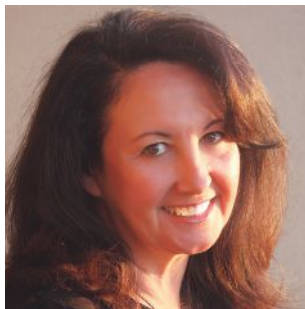




## PROFILE/22&gt;

## YVONNE PENDLETON

DIRECTOR,  
SOLAR SYSTEM EXPLORATION RESEARCH  
VIRTUAL INSTITUTE



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ESA PHOTO  
"We have found a compromise that is OK for both countries, for the other participating states and also for industry," Brigitte Zypries (above), Germany's space minister, said of an agreement under which Germany and France will back the Ariane 6 rocket and scrap the Ariane 5 Midlife Evolution.

# German-French Compromise Paves Direct Path to Ariane 6

PETER B. de SELDING, PARIS

The German government has agreed to drop its demand that Europe develop a long-planned upgrade of today's Ariane 5 rocket and instead proceed with a new-generation Ariane 6 that borrows heavily on Ariane 5 technology, Germany's space minister said.

The decision ends an impasse that has bedeviled the European Space Agency for more than two years as it prepares for a Dec. 2 conference of its governments.

While noting that certain funding details and a clarification of industry's risk-taking guarantee remain to be ironed out, Brigitte Zypries said Germany and France now agree to back Ariane 6 and to scrap the Ariane 5 Midlife Evolution (ME) rocket that European governments have been developing for several years.

"We have found a compromise that is OK for both countries, for the other participating states and also for industry," Zypries said in a Nov. 15 emailed response to *SpaceNews* questions. "The important elements are the joint intention to develop a new launcher as part of a concept based mainly on Ariane 5 ME technology and Vega, and a new launcher governance."

Vega is the Italian-led small-satellite launcher. A Vega upgrade, along with Ariane 6, Europe's participation in the international space station and a European Mars exploration project, will all be on the table at the ministerial conference in Luxembourg.

The debate about future Ariane 5 investment has been the major roadblock to an agreement on all these subjects. Germany had said the Ariane 6 business model, industrial work-share distribution

and the role of Ariane manufacturers in assuming market risk all were too ill-defined to permit a full-scale go-ahead.

Zypries is Germany's parliamentary state secretary in the Federal Ministry for Economic Affairs and Energy, and the government's coordinator for aviation and space policy.

Her French counterpart, Genevieve Fioraso, who is state secretary in the French Ministry for Higher Education and Research, alluded to a French-German agreement in a briefing with journalists Nov. 12.

Fioraso and Zypries met Nov. 13 in Cologne, Germany, with ministers from Italy and several other governments.

Germany had said the Ariane 5 ME, which is basically today's Ariane 5 with a new, multi-ignition

SEE COMPROMISE PAGE 8

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# **SPACENEWS**

## **ISSUE ALERTS**

### **December highlights include:**

- Continuing coverage of the Antares and SpaceShipTwo Accidents
- U.S. budget — the CR that's been funding federal agencies since Oct. 1 is set to expire Dec. 11. No telling whether Congress will pass additional appropriations the week of Dec. 1, Dec. 8, or Dec. 15

### **December 1<sup>st</sup> Issue**

- 25th anniversary package
- Coverage of Orion's EFT-1 launch atop a Delta 4 (Scheduled for Dec. 4)
- Satellite Telecom (Monthly Feature)

### **December 8<sup>th</sup> Issue**

- Coverage of ESA Ministerial in Geneva
- Coverage of SpaceX's 5th cargo launch to the ISS (Dec. 16)
- Launch Report (Monthly Feature)

### **December 15<sup>th</sup> Issue**

- Annual Year in Review (Special Editorial Report)
- Earth Science (Monthly Feature) Curtain raiser on NASA's Soil Moisture Active Passive mission launching in late January

**Contact your representative today**

**Candy Maness**

cmaness@spacenews.com  
+1 318-550-1727

**Paige McCullough**

pmccullough@spacenews.com  
+1 571-278-4090

**Tony Kingham**

tony.kingham@worldsecurity-index.com  
+44 (0) 20 8144 5934

**Emmanuel Archambeaud**

earchambeaud@defcommunication.com  
+(331) 47307180



November 24, 2014

# NEWS BRIEFS

## Culberson To Chair NASA House Approps Subcommittee

U.S. Rep. John Culberson (R-Texas), a strong advocate of NASA's exploration and planetary science programs, will chair the subcommittee of the House Appropriations Committee that funds the agency in the next Congress, the committee announced Nov. 20.

In a statement, committee chairman Rep. Hal Rogers (R-Ky.) released the list of the 12 subcommittee chairs approved by the Republican Steering Committee. That list included Culberson as chairman of the Commerce, Justice, and Science (CJS) subcommittee, which funds NASA as well as the National Oceanic and Atmospheric Administration and the National Science Foundation (NSF).

Rep. Rodney Frelinghuysen (R-N.J.) will continue to head the defense subcommittee, which funds military space and missile defense programs.

Culberson was widely considered to be one of two front-runners to succeed Rep. Frank Wolf (R-Va.), the previous CJS subcommittee chairman, who is retiring at the end of this year. Rep. Robert Aderholt (R-Ala.), the current vice chairman of the subcommittee, was also in contention for the post, but will instead retain the chairmanship of the agriculture and rural development subcommittee.

"I am honored that my House Republican colleagues have chosen me as the new chair of the Commerce, Justice, Science Appropriations Subcommittee," Culberson said in a Nov. 20 statement. "I'm grateful to have earned Chairman Hal Rogers's confidence, and it is a real privilege to succeed Chairman Frank Wolf."

In the statement, Culberson said he would emphasize both law enforcement and science as subcommittee chairman. "It will also be a source of great joy for me to help lift up

NASA and the NSF to ensure that America will always lead the world in space exploration and scientific discoveries," he said.

In an interview with *SpaceNews* in September, Culberson said his top priorities for NASA included accelerating development of the Space Launch System heavy-lift rocket and Orion spacecraft as well as funding key space science missions. However, he was skeptical about NASA's Asteroid Redirect Mission, which seeks to move a small asteroid into lunar orbit to be visited by astronauts in the 2020s. "It just doesn't, in my mind, make financial sense when NASA's money is so scarce and so hard to come by," he said in the interview. "I don't think it's productive to add another really extensive project to their plate when they're telling the scientific community they're short money to do top-priority missions like Europa."

Culberson is perhaps best known for his advocacy for a mission to Europa, a large moon of Jupiter believed to have a liquid water ocean beneath its icy surface that may be able to support life. As a member of the CJS subcommittee, he worked to set aside funding for a Europa mission in recent appropriations bills, including \$100 million in the fiscal year 2015 CJS appropriations bill passed by the House in May. NASA had requested only \$15 million for Europa mission studies in its 2015 budget request.

"It didn't have an advocate. It didn't have anybody pushing for it," Culberson said of Europa mission proposals in the September interview. "I knew it was the likeliest place to find life on another world. So that's sort of why I picked it up. Europa needed a friend."

## NASA Contract Puts Orbital's Pegasus XL Back on the Board

Orbital Sciences Corp. of Dulles, Virginia, will launch a small NASA heliophysics mission aboard the venerable Pegasus XL air-launched rocket in 2017 under a \$56.3 million contract award announced Nov. 20.

NASA's Ionospheric Connection Explorer (ICON) mission is now set to launch in June 2017 from the U.S. Army's Reagan Test Site on the Kwajalein Atoll in the Pacific, NASA said in a press release. The \$200 million heliophysics probe will spend its two-year primary mission studying the ionosphere: a region of space ranging from about 90 kilometers to 900 kilometers.

Orbital's price has risen for Pegasus XL, which was once a staple of the company's launch business but now is seldom flown. The air-launched rocket, dropped from a modified Lockheed L-1011 TriStar jetliner, last launched in June 2013, when it lofted NASA's Interface Region Imaging Spectrograph spacecraft. NASA paid about \$40 million for that launch, the 42nd for Pegasus.

Orbital has blamed a sharp downturn in the number of small-satellite launches for the drought of Pegasus business. The small launcher, which can send about 450 kilograms to low Earth orbit, is Orbital's most experienced, reliable rocket.

## Jim Watzin Returning To NASA as Mars Czar

Veteran NASA program manager Jim Watzin has left the U.S. Missile Defense Agency to become director of NASA's Mars Exploration Program in Washington, the



▲ U.S. senior adviser Jason Y. Kim said regulatory measures put into place should be technology-neutral.

## U.S. Warns EU Against Making Galileo Mandatory

The U.S. government has alerted the European Union that any preferential treatment the EU gives to its Galileo positioning, navigation and timing network will likely violate World Trade Organization (WTO) agreements signed by the United States and the 28-nation EU.

In particular, U.S. government officials voiced concerns that the EU is weighing equipment mandates for aviation, car-accident reporting and emergency-call regulations that could unfairly tip the scales in favor of Galileo to the detriment of U.S. GPS-enabled hardware.

In a presentation to the 9th Meeting of the International Committee on GNSS, held Nov. 10-14 in Prague, a senior GPS official said the United States and the EU have signed a wide body of satellite navigation agreements designed to promote open market access and interoperability.

These protocols include the WTO's Agreement on Technical Barriers to Trade, which prohibits discrimination among goods based on nontariff measures including regulations and certification procedures.

Jason Y. Kim, senior adviser at the U.S. National Coordination Office for Positioning, Navigation and Timing, said regulatory measures put into place should be technology-neutral, putting GPS-equipped hardware on an equal footing with Galileo equipment if both meet the regulations' performance requirements.

The United States and the European

Commission, the EU executive arm and Galileo's owner, in June 2004 agreed to a series of measures to assure interoperability of their systems.

But unlike GPS, Galileo — which is still in development but is expected to launch much of its constellation in 2015-2016 — has always had a commercial ambition.

European Commission officials have said in recent months that they are still weighing how to stimulate Galileo use, especially through regulatory measures requiring that navigation equipment be installed on aircraft, automobiles and other platforms.

"Requiring specific systems arbitrarily prevents or penalizes imports of goods having perfectly functional GNSS capability," Kim said.

The United States and Russia both have global satellite navigation networks in place. China's Beidou system, which in addition to positioning, navigation and timing includes a short-messaging capability, is operational in Asia and will be global within two years. Galileo will be globally operational toward the end of the decade.

India and Japan have launched wide-area regional satellite navigation systems.

The United States, the EU and Japan all signed the WTO's Agreement on Government Procurement, which stipulates nondiscrimination in regulations. China, India and Russia are not yet signatories.

space agency said in a Nov. 21 press release.

Watzin, who will manage NASA's roughly \$500-million-a-year Mars portfolio beginning Dec. 1, succeeds Doug McCuistion, who left his post in December 2012 after eight-and-a-half years on the job. McCuistion was the longest-serving Mars czar in the history of the post, which was created in 2000 to get the Mars program back on track after back-to-back mission failures.

Watzin was most recently technical director and deputy program executive for Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance at the Missile Defense Agency in Huntsville, Alabama. Before that, he did a stint as director of space programs at ATK and spent many years at NASA's Goddard Space Flight Center in Greenbelt,

Maryland, leading numerous flight projects and program offices.

Jim Green, NASA's director of planetary science, has been acting Mars Exploration Program director since McCuistion's departure.

SEE NEWS BRIEFS PAGE 9

## CORRECTION

The news brief "Orbital Asked Judge To Force Turnover of Launch Hardware" [Nov. 3, page 8] should have said Orbital Sciences Corp.'s cargo delivery contract with NASA is worth \$1.9 billion.



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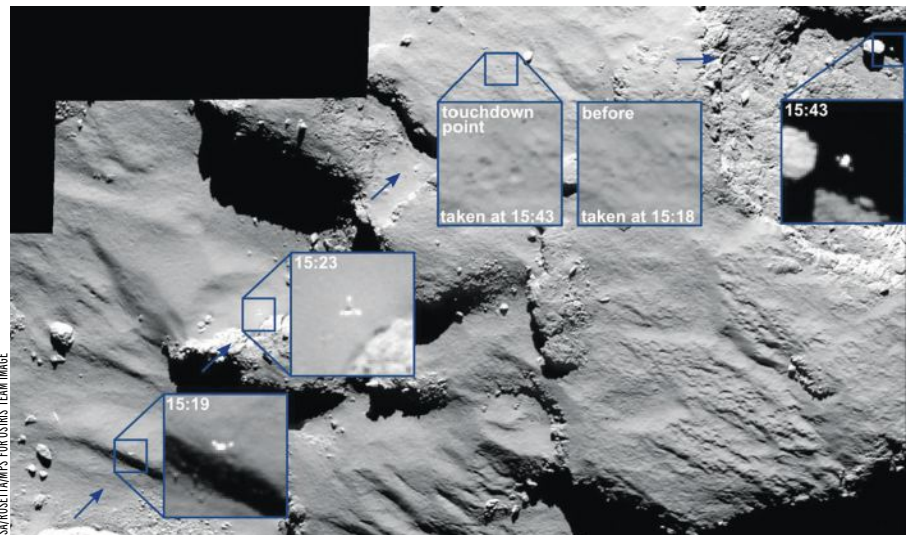
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# TOUCHDOWN!

Congratulations to ESA for achieving the first successful comet landing, over 300 million miles from Earth. Ten years ago Ariane 5 launched Rosetta on its epic journey to rendezvous with Comet 67P/Churyumov-Gerasimenko and collect vital information about the origins of our solar system. Space agencies know to launch smart.

@arianespace

November 24, 2014



Images show Rosetta's Philae lander as it approached and then rebounded from its first touchdown on Comet 67P.

## Philae Managers Say Recovery Possible as Comet Nears Sun

PETER B. de SELDING, PARIS

Managers of Europe's Philae comet lander, which went into hibernation Nov. 15 after its battery drained 56 hours after touchdown, on Nov. 18 made a virtue of a necessity in saying Philae's overly shadowed location will be an advantage as Comet 67P approaches the sun in the coming months.

At that point, they said, it is "probable" that the increased doses of solar power will warm the lander, permitting its secondary battery to power up sufficiently to renew communications via the Rosetta spacecraft orbiting overhead.

In response to *SpaceNews* inquiries, Stephan Ulamec, Philae project manager at the German Aerospace Center, DLR, on Nov. 18 said such a scenario "is very likely to happen. Philae will not overheat on its way to the sun because of its shaded position. Getting closer to the sun means Philae could warm up, wake up and reload its secondary battery by solar power."

As of Nov. 18 Philae managers were still sifting through data from the last communication Philae had with Rosetta early Nov. 15 before its batteries drained.

Early results confirm that the last of Philae's instruments to be switched on, the SD2 Sampling, Drilling and Distribution system, deployed correctly and made an attempt to penetrate the surface ice and collect a soil sample. It remained unclear whether a sample was collected and put into Philae's micro-oven for analysis. There is no evidence either way, DLR said.

"The strength of the ice found under a layer of dust on the landing site is surprisingly high," said Klaus Seidensticker of DLR's Institute of Planetary Research.

Before it went dark, Philae was raised several centimeters and commanded to rotate 35 degrees to optimize its exposure to the sun. DLR said the telemetry from the last data transmission early Nov. 15 confirmed that this maneuver occurred.

Data from Philae's MUPUS instrument, or Multi-Purpose Sensors for Surface and Sub-Surface Science, suggest that while the MUPUS hammer was deployed and its power increased, "we were not able to go deep into the surface," said Tilman Spohn of DLR's Institute of Planetary Research. The instrument nonetheless delivered information on the comet's surface.

The SD2 drill was the last of Philae's instruments to be deployed because ground teams wanted to collect as much data as possible from those instruments whose measurements posed no risk of destabilizing the lander on its precarious perch. Only two of its three legs were securely on the surface.

After separating from its mothership, Philae arrived near dead center in its intended landing area on Comet 67P/Churyumov-Gerasimenko. But its thruster system, designed to keep it secured on the surface, failed to deploy, as did the harpoons that were to affix it to the surface. Philae thus rebounded off the comet's surface, reaching up to a kilometer in elevation and traveling for about a kilometer over around two hours.

It then touched down and rebounded again, this time for seven minutes, before coming to its final resting place.

Ground teams are still combing through data to determine exactly where Philae is. On Nov. 17 the European Space Agency released a series of photos from Rosetta's Osiris camera showing Philae's descent. A subsequent photo shows the same area after Philae's rebound, with small footprints in the dust that were not visible in a previous photo of the spot.

DLR has concluded that Philae worked 56 hours continuously on the surface of the comet, plus the seven-hour descent from Rosetta during which its MUPUS and Rosetta Lander Magnetometer and Plasma Monitor multisensor experiments both were active. Including the descent, then, Philae logged 63 hours of data.

The only two instruments that were not activated were thermal sensors and accelerometers attached to the harpoon anchoring system.

Philae's exploits 500 million kilometers from Earth attracted global attention. With the lander now out of the spotlight, at least until its battery is recharged next summer, the Rosetta satellite will continue its unprecedented close-in study of a comet as it approaches the sun. Rosetta is expected to follow the comet for another 18 months or more.

ESA Rosetta managers are debating whether to land Rosetta on Comet 67 at the end of its operational life, but no decision has been made.

Twitter: @pbdes  
Email: pdeselding@gmail.com



November 24, 2014

# Industry Worries Government 'Backsliding' on Orbital Debris

JEFF FOUST, COLLEGE PARK, Md.

Despite growing concern about the threat posed by orbital debris, and language in U.S. national space policy directing government agencies to study debris cleanup technologies, many in the space community worry that the government is not doing enough to implement that policy.

Some speakers at a workshop held here by the University of Maryland's Center for Orbital Debris Education and Research (CODER) expressed concern that the government was "backsliding" in its commitment to reducing the growth of orbital debris, let alone tackling the more complex issues of removing orbital debris.

The 2010 National Space Policy directed government agencies to follow orbital debris mitigation guidelines designed to minimize the creation of new debris. The policy also, for the first time, directed NASA and the U.S. Defense Department to study ways to remove existing debris, a concept known as remediation.

"Everybody who's looked at the problem comes to the same conclusion: If we don't start removing five to 10 objects per year for the next 100 years, we'll have an unstable environment," Donald Kessler, a retired NASA scientist who was one of the pioneers in orbital debris research, said in a keynote talk at the workshop Nov. 18.

NASA and Defense



NASA and U.S. Defense Department officials at the workshop said that despite the policy direction, they have only started to address orbital debris remediation issues.

Department officials at the workshop said that despite the policy direction, they have only started to address orbital debris remediation issues. "This past year, we've spent a lot of time thinking about remediation," Thomas Cremens, senior adviser for policy and strategy implementation at NASA, said during a panel session Nov. 18.

However, Cremens added that NASA has decided to focus on

early stage technologies that may eventually be useful for debris remediation as well as other applications, including its Asteroid Redirect Mission program, rather than as a separate initiative. "We do not have an active debris remediation program," he said.

Josef Koller, space policy adviser in the Office of the Secretary of Defense, said an increasing number of companies

have discussed orbital debris remediation approaches with his office. While those discussions have yet to lead to formal policies and plans, he said the United States should take a leadership role in international discussions about debris cleanup.

"I think a lot of countries are looking to us for leadership: How do we solve not only the technical questions but also the legal questions?" he said.

The Defense Department and other agencies have instead focused their attention on debris mitigation efforts. Koller said his office was working to limit the exemptions to current debris guidelines that it grants to its missions. "The goal really is to start drawing down those granted exemptions and, by 2018, have a zero environment for granted exemptions," he said.

Other agencies also implement debris mitigation guidelines, either for their own satellites or those over which they have regulatory oversight. The Federal Communications Commission (FCC), for example, requires companies whose satellites it licenses to follow those guidelines.

"The FCC, at one time, was very aggressive in its enforcement" of the orbital debris guidelines, James Dunstan, founder of Mobius Legal Group, said in a Nov. 19 keynote at the CODER workshop. He cited, as one example, the FCC's rejecting a license application because it lacked sufficient detail in its orbital debris mitigation plan.

Dunstan said he believed that this strong enforcement was linked to the 2007 test of a Chinese anti-satellite (ASAT) weapon and the 2009 collision of an Iridium and Russian Cosmos satellite; both incidents created significant debris. That enforcement, he argued, has lagged as those incidents faded into the past.

"I would contend that there has been significant backsliding since 2010, since the fear of Iridium/Cosmos and the Chinese ASAT have gone away," he said. He noted the FCC recently allowed Iridium to amend its orbital debris plan to allow several satellites that had exhausted their fuel to naturally deorbit over 25 years, rather than actively deorbit over several months.

The workshop discussed a number of technical concepts for orbital debris cleanup, from tugs that would move defunct satellites to a laser that nudges smaller pieces of debris into lower orbits. Even engineers there, though, acknowledged that orbital debris cleanup was not solely a technical problem.

"It's going to be a little hard for some of us to stand back and let lawyers and policy people get involved and start telling us how to solve the problem," said Eric Sundberg, principal scientist at the Aerospace Corp., in a Nov. 19 panel presentation on remediation technologies.

Twitter: @jeff\_foust  
Email: jfoust@spacenews.com

## Haney: U.S. Partners To Have Indirect Access to Space Fence Data

MIKE GRUSS, WASHINGTON

The U.S. Defense Department's expanding network of international partners in space surveillance will have indirect access to data from the Pentagon's next-generation Space Fence tracking system, a top U.S. military official said.

"Once operational, the Space Fence is scheduled to serve as an additional sensor in the Space Surveillance Network, effectively enhancing the information available to all existing and future [space situational awareness] partners," Navy Adm. Cecil Haney, commander of Strategic Command, said in a written response to *SpaceNews* questions. "The same type of data available now will be shared with our partners once the Space Fence is operational."

To date, Strategic Command has announced data-sharing agreements with at least seven countries and 44 companies, but few details about those agreements have been made public. Some in the space community had wondered how much of the Air Force's new \$1 billion Space Fence would be part of those agreements, if at all.

Strategic Command's data-sharing agent is the Joint Space Operations Center (JSpOC) at Vandenberg Air Force Base, California, which receives data from the Space Surveillance Network, a combination

of terrestrial and space-based sensors, both optical and radar, Haney said. The network tracks and catalogs satellites and debris, information that is used for warning operators of potential collisions, among other purposes.

Strategic Command has announced

surveillance assets, will join the network in 2019. To accommodate those data, as well as other sensors both internal and external to the Defense Department, the Air Force is undertaking a modernization of the JSpOC's computing systems, a program known as the JSpOC Mission System.

**"Once operational, the Space Fence is scheduled to serve as an additional sensor in the Space Surveillance Network, effectively enhancing the information available to all existing and future [space situational awareness] partners."**

Navy Adm. Cecil Haney

space situational awareness data-sharing agreements with Australia, Japan, Italy, Canada, France, the Republic of Korea and the United Kingdom. It also has agreements with the European Space Agency and Europe's Eumetsat weather satellite organization, Haney said.

The Space Fence, an S-band radar that will be capable of tracking greater numbers of smaller objects than current U.S. space

The Space Fence would track about 200,000 objects and make 1.5 million observations per day, about 10 times the number made by existing or recently retired assets including the Air Force Space Surveillance System, which was mothballed in 2013. The system initially will consist of a radar site on the Kwajalein Atoll in the Pacific Ocean near the equator.

In June, Lockheed Martin Mission

Systems and Training of Moorestown, New Jersey, won a \$914 million contract from the Air Force to develop the Space Fence. AMEC Foster Wheeler of London, which provides architectural and engineering work, and General Dynamics C4 Systems SATCOM Technologies of Scottsdale, Arizona, are major subcontractors on the program.

In a Nov. 18 interview, Steve Bruce, vice president for advanced systems at Lockheed Martin Mission Systems and Training, said the company anticipates a Jan. 5 groundbreaking at the Kwajalein site and a critical design review to test the maturity of the Space Fence technologies in March.

Most recently, Lockheed Martin has been focusing on completing environmental impact studies and site surveys as well as delivering construction equipment and materials to the Marshall Islands, Bruce said.

The Air Force has asked for virtually no changes to the contract since June, Bruce said.

"We're moving along very well for a big program," Bruce said. Lockheed Martin expects to complete and deliver the system in September 2018, he said.

Twitter: @Gruss\_SN  
Email: mgruss@spacenews.com



November 24, 2014

# Virginia May Seek Federal Funds for Wallops Spaceport Repairs

JEFF FOUST, WASHINGTON

After the failure of an Orbital Sciences Corp. Antares rocket caused as much as \$20 million in damage to a state-owned launch pad, Virginia's two U.S. senators said they may seek federal funds to cover repair costs.

In a joint statement provided by their offices on Nov. 20, Sens. Tim Kaine and Mark Warner, both Democrats, said they would work with members of both parties in the House and Senate to identify funding to pay for the damage to the Mid-Atlantic Regional Spaceport (MARS) on Wallops Island, Virginia.

"Sens. Warner and Kaine are working with their colleagues from both parties, both chambers, and both states to see if there may be federal resources available to help rebound from this setback," the statement said. MARS is a joint venture of the states of Maryland and Virginia.

The *Richmond Times-Dispatch* reported Nov. 18 that Virginia Gov. Terry McAuliffe, also a Democrat, had asked the senators for funding to cover the repair costs to the spaceport. A spokesman for the governor's office did not respond to a request for comment on the report.

Pad 0A at MARS was damaged after an Antares rocket suffered an engine malfunction less than 15 seconds after liftoff Oct. 28. The rocket fell back to the ground near the pad and exploded.

In a Nov. 20 interview, Dale



Pad 0A at the Mid-Atlantic Regional Spaceport on Wallops Island, Virginia, was damaged after an Antares rocket suffered an engine malfunction less than 15 seconds after liftoff Oct. 28. The rocket fell back to the ground near the pad and exploded.

Nash, executive director of the Virginia Commercial Space Flight Authority, said the spaceport was still finalizing damage assessments to the pad infrastructure, but believed it had a good handle on what repairs

were needed and their costs. "The estimate is probably no more than \$20 million," he said.

Much of the planned repairs, he said, involves concrete and other structural damage to the pad, as well as plumbing and

related systems. "A lot of electrical systems and sensors are fried," he said.

Among the most visible damage to the site involves the four lightning towers, resembling tall flagpoles,

surrounding the pad. Two of the four poles fell in the explosion, Nash said, and all four will likely be replaced.

Many other key elements of the pad, though, escaped damage in the accident. "All the tankage seems to be in good shape," he said. "The water tower also appears to be in good shape."

Nash was optimistic that the damage could be repaired well in advance of the next launch. "There's really nothing that we don't know how to rebuild," he said. "There's not too much that should keep us from supporting the schedule that Orbital has for a launch in early 2016."

In a Nov. 5 conference call, Orbital officials said they were accelerating the development of an upgraded version of the Antares with new first-stage engines, which they plan to have ready for a first launch in 2016. The company has yet to disclose its choice of engine that will replace the AJ-26 engine used previously on the Antares first stage and linked to the Oct. 28 failure.

Orbital is still conducting an assessment of damage to its own equipment at the launch pad, company spokesman Barron Beneski said Nov. 21. He confirmed comments by Orbital Chief Executive David W. Thompson in the Nov. 5 conference call that the cost to repair or replace any company-owned equipment at the pad will be covered by insurance.

Twitter: @jeff\_foust  
Email: jfoust@spacenews.com

## ATK Executive Hints at Antares Engine Selection in Endorsing Orbital's Recovery Plan

PETER B. de SELDING, PARIS

Alliant Techsystems (ATK) Chief Executive Mark W. DeYoung on Nov. 19 said there are no near-term liquid-propulsion alternatives to Russian engines for U.S. rockets.

In a conference call with investors to explain why ATK still believes in its planned merger with Orbital Sciences Corp. despite the Oct. 28 failure of Orbital's Antares rocket, DeYoung said his company continues to hunt for rockets to use ATK's solid-propulsion systems. But for liquid propulsion, he said, Russia is unavoidable for now.

"As much as the country may desire to have an alternative propulsion system which does not rely on Russian liquid propulsion, there are no solutions available that I am aware of in the near term" that could replace "the solutions which are being used right now, which are Russian-based engines," he said.

Arlington, Virginia-based ATK conducted an in-depth review of Orbital's post-Antares failure recovery plan, which includes finding replacement rockets to launch one or two cargo modules to the international space station to fulfill the terms of Orbital's contract with NASA.

Orbital has also said it would scrap its current Russian-origin AJ26 first-stage Antares engine for an unnamed alternative that will be in service in late 2016.

Neither DeYoung nor ATK Chief Financial Officer Neil S. Cohen identified the replacement engine, but their comments suggested that Dulles, Virginia-based Orbital has in fact selected a Russian engine to replace the AJ26, which has been tentatively implicated in the Antares failure.

Cohen said ATK's review of Orbital's recovery program included an "assessment of customer and political risks" associated with Orbital's Antares plans, using a phrase normally associated with purchases from nations with unstable political regimes or with tense relations with the United States.

Cohen said the ATK review also "stress-tested" Orbital's assumptions about the availability and cost of third-party rockets for launching one or two space station cargo missions, and about replacing the AJ26 with a new engine.

ATK's board of directors concluded that Orbital has correctly assessed the risks and costs of its Antares recovery plan in concluding that its effect on the company's revenue and profit in 2015

will not be substantial.

Cohen said ATK also agreed with Orbital that the likelihood of Orbital winning a follow-on space station supply contract with NASA has not been reduced because of the Antares failure and will not suffer from the change in engine.

He said Orbital's recovery plan includes "key milestones and deliverables that can be monitored in the coming weeks" before ATK and Orbital shareholders vote on the merger of Orbital with ATK's Aerospace and Defense division.

The companies agreed to postpone the planned Dec. 9 shareholder vote to Jan. 27 to allow time to assess the deal after the Antares failure.

The merger involves ATK's spinning off of its Sporting Goods division into a new company, called Vista Outdoor. ATK's Aerospace and Defense group would then merge with Orbital, with the combined company becoming a wholly owned ATK subsidiary.

The two companies said the transaction is expected to close in February.

Orbital's stock fell dramatically following the Antares failure, which destroyed an Orbital-built module carrying supplies to the international

space station under a services contract with NASA.

But since then the stock has recovered and as of Nov. 19 was marginally up from where it traded on the eve of the April 28 merger announcement.

For reasons unrelated to the Antares rocket failure, ATK's stock has also had a rocky 2014 and at the stock market's close Nov. 19 was down 18 percent since the Orbital deal was announced.

Without disclosing many details, Orbital Chief Executive David W. Thompson assured investors in a Nov. 17 statement that the company would fulfill the NASA supply contract by launching space station cargo on one or two launches provided by third parties without "material adverse financial changes in 2015 or future years." Thompson will become chief executive of the newly named Orbital ATK.

While Orbital officials had expressed confidence immediately after the failure that the merger plans remained intact, ATK had been more circumspect, saying it wanted to evaluate the consequences in detail.

Twitter: @pbdes  
Email: pdeselding@gmail.com



November 24, 2014

# Final Assembly and Testing Begins on NASA's Next Mars Mission

DAN LEONE, WASHINGTON

Prime contractor Lockheed Martin Space Systems has started assembling the InSight lander that will carry a pair of European science instruments to the surface of Mars for a two-year seismology mission scheduled to launch in 2016, the Denver-based company said in a Nov. 17 press release.

InSight, led by the Jet Propulsion Laboratory in Pasadena, California, is the 12th in NASA's Discovery series of small, competitively selected, cost-capped science missions. NASA picked the lander in August 2012 over the Comet Hopper and Titan Maritime Explorer missions, the novel designs of which the agency deemed too risky to gamble on with its budget trending flat.

Spacecraft integration will last about six months, Lockheed Martin said in its press release. InSight's two European instruments are scheduled to arrive within that time frame and start environmental tests this coming summer in Denver, NASA spokesman Guy Webster said in a Nov. 19 email.

InSight is based heavily on the Lockheed-built Mars Phoenix lander that launched in 2007, landed in 2008 and went silent after about five months of surface operations — two months more than called for in its primary mission.

Development of InSight began in December 2013, when the agency committed to a cost of \$381.9 million, excluding launch. The estimate places InSight well within its development cost cap of \$425 million in 2010 dollars.



Technicians in a Lockheed Martin clean room prepare NASA's InSight Mars lander for propulsion proof and leak testing. InSight is scheduled to launch in 2016.

Tack on another \$159.9 million for launch, and the total bill for the mission rises to \$541.8 million, according to documents accompanying NASA's 2015 budget request.

InSight is slated to launch aboard a United Launch Alliance Atlas 5 rocket from Vandenberg Air Force Base in California March 8, 2016, in what will be NASA's first Mars mission to launch from anywhere other than Cape Canaveral Air Force Station in Florida. The lander is slated to touch down near the

martian equator in a region known as Elysium Planitia on Sept. 20, 2016.

Once InSight separates from its rocket, a Lockheed Martin team at the company's Mission Support Area in Waterton Canyon, Colorado, will take over spacecraft operations. InSight's roughly two-year primary seismology mission begins when the lander reaches the surface. The data could help scientists understand how small, rocky planets like Mars and Earth form.

InSight could be the last in

the Discovery line with a predominantly international instrument suite. Beginning with the 13th Discovery competition, underway since Nov. 5 with a winner to be announced around September 2015, international contributions to a Discovery mission's instrument package may not exceed one-third of the mission's total instrument budget.

Even one of InSight's two primary instruments easily exceeds that limit. For example, the Seismic Experiment for Interior Structures, provided

by the French space agency, CNES, cost about \$42 million; NASA's financial contribution to InSight's instrument suite — a sensor that tracks Mars' rotational axis, a robotic arm to move the European instruments from the spacecraft to the ground, and two black-and-white cameras — totals only \$18 million, according to the 2015 budget request.

InSight's other main instrument is the German-built Heat Flow and Physical Properties Package, a small drilling rig based on the Multi-Purpose Sensors for Surface and Subsurface Science package that landed on Comet 67P Nov. 12 as part of the European Space Agency's Rosetta mission. DLR's InSight instrument will cost about 15 million euros, or just under \$19 million, Tilman Spohn, head of DLR's Institute for Planetary Research in Berlin, said in a Nov. 19 email.

NASA's rationale for barring significant international contributions to Discovery missions is to avoid footing the bill for getting non-U.S. instruments to distant planets.

"The intent is to not have U.S. spacecraft flying with non-U.S. instruments and mostly non-U.S. science teams," Michael Lew, lead Discovery program scientist, told the NASA-chartered Small Bodies Advisory Group in July.

NASA spokesman Dwayne Brown did not reply to a request for comment Nov. 18 about whether NASA's new policy was now a permanent fixture in the Discovery program.

Twitter: @Leone\_SN  
Email: dleone@spacenews.com

## NASA Extends Unfunded Commercial Crew Agreement with Blue Origin

JEFF FOUST, WASHINGTON

NASA announced Nov. 14 that it has extended its unfunded agreement with Blue Origin to support that company's effort to develop a commercial crew spacecraft, even though the company is not competing for a NASA contract to provide transportation to the international space station.

NASA and Blue Origin signed an extension Oct. 31 of their existing Space Act Agreement, originally part of the agency's Commercial Crew Development Round 2 (CCDev2) award made in April 2011. This extension, like previous ones dating back to February 2013, is an unfunded one where NASA provides technical guidance but no money to Blue Origin.

One milestone covers an in-flight test of a "pusher" escape system, where rocket engines at the base of the vehicle would push the spacecraft away from its launch vehicle in the event of an abort. Under the CCDev2 milestone, NASA personnel would review data and video from the test, which would use an

unspecified subscale booster.

A second milestone involves a flight test of Blue Origin's BE-3 rocket engine, a liquid oxygen/liquid hydrogen engine that the company has tested on the ground in earlier milestones. That flight would test the engine on a "representative suborbital mission," which NASA

and propellant tank milestones would be achieved by September 2015, while the pusher escape system test milestone is scheduled for March 2016. The overall agreement now expires April 17, 2016.

"The team at Blue Origin has made tremendous progress in its design, and we're excited to extend our partnership

**"The team at Blue Origin has made tremendous progress in its design, and we're excited to extend our partnership to 2016."**

Kathy Lueders

personnel would be invited to observe.

The third milestone involves a flight test of a subscale propellant tank, also on a representative suborbital mission. The assembly review for that tank was a milestone in a prior unfunded extension of Blue Origin's CCDev2 agreement.

The extension states that the BE-3

to 2016," Kathy Lueders, manager of NASA's commercial crew program, said in the Nov. 14 statement announcing the extension of the Blue Origin agreement.

The CCDev2 program was originally established to help companies mature technologies for commercial crew transportation systems that would feed into

later competitions for the development of systems to carry NASA astronauts to and from the ISS. Boeing, Sierra Nevada Corp., and Space Exploration Technologies Corp. also received funded CCDev2 awards.

While Blue Origin received \$22 million in its original CCDev2 award, it decided, unlike the other three funded companies, not to compete in later phases of the program. Instead, the company has continued development of what it simply calls its "Space Vehicle" using internal funding. In September, NASA awarded contracts valued at up to \$6.8 billion to Boeing and SpaceX to develop and test their commercial crew vehicles, a decision that Sierra Nevada has protested to the Government Accountability Office.

"It's important to keep a pulse on the commercial human spaceflight industry as a whole," Lueders said in the NASA statement, "and this partnership is a shining example of what works well for both industry and the government."

Twitter: @jeff\_foust  
Email: jfoust@spacenews.com



November 24, 2014

# Europe's Satellite Operators Urge Swift Development of Ariane 6

PETER B. de SELDING, PARIS

The president of the European Satellite Operators Association (ESOA) on Nov. 19 applauded the apparent agreement between France and Germany on a next-generation Ariane 6 rocket and said the vehicle needs to be in service as quickly as possible.

If it is not, said Eutelsat Chief Executive Michel de Rosen, ESOA's president, SpaceX of the United States will establish itself as a leader in the commercial market — a position from which it will not be dislodged easily.

"Our ESOA message: Hurry up," de Rosen said in a briefing here less than two weeks before European governments are set to meet to decide Ariane 6's funding and development period. "Each year that passes will see SpaceX advance, gain market share and further reduce its costs through economies of scale."

Hawthorne, California-based SpaceX, formally known as Space Exploration Technologies Corp., has already begun to take market share from Europe's Arianespace launch service provider, mainly for the launch of satellites that would sit in the current heavy-lift Ariane 5 rocket's lower position, which is reserved for the smaller of two satellites the vehicle carries to orbit for commercial customers.

Every, France-based Arianespace has responded by squeezing, to a limited degree, its supplier base. But Ariane 5 builders are also Arianespace shareholders, limiting



▲ "Our ESOA message: Hurry up," Eutelsat Chief Executive Michel de Rosen said. "Each year that passes will see SpaceX advance, gain market share and further reduce its costs through economies of scale."

the company's leverage on them.

Arianespace has also begun reducing prices for satellites in the Ariane 5 lower position, in part by raising prices for the heavier, upper-berth satellites.

Yohann Leroy, Eutelsat's chief technical officer, said this policy has been possible in part because the Ariane 5's competitors for heavy satellites — the Russian Proton and Zenit/Sea Launch

rockets — have confronted quality control and supply chain issues.

Leroy said this situation will not last long, especially if, as scheduled, SpaceX introduces its Falcon Heavy sometime in 2015 and thereby competes for 6,000-kilogram-class satellites as well as lighter spacecraft.

Asked whether Eutelsat, the world's third-largest commercial satellite fleet operator by revenue,

considered the Proton and Zenit rockets out of the commercial market, de Rosen said Eutelsat has been told that the Russian government will do what it takes to keep both vehicles viable in the market.

Eutelsat, de Rosen said, pointedly asked SpaceX in September what its medium-term Falcon 9 pricing policy would be. The company wondered whether SpaceX would raise prices once it had secured a sizable share of the commercial market.

SpaceX's response, he said, was that Falcon pricing would remain stable for a time and then head down, not up, as new technology, scale economies and partial reuse of the vehicle produced their intended effects.

While de Rosen occasionally sounded like a cheerleader for Team France or Team Europe — his company has historically favored both Ariane 5 and European satellite builders — he said Eutelsat would make no guarantees with respect to Ariane 6.

"If they meet their objectives in terms of flexibility and reliability, then we would certainly look favorably on the vehicle," de Rosen said, adding that Eutelsat already had volunteered to place one of its satellites on the inaugural Ariane 6 flight.

"We are just the customers. What we want, as satellite operators, is at least three launch options. We don't want anyone in a monopoly position."

The 20-nation European Space Agency asked ESOA to weigh in

with its opinions early on in the Ariane 6 design process, a move that helped change the Ariane 6 design over the past two years.

ESA Director-General Jean-Jacques Dordain, de Rosen said, has been the driving force behind this evolution. "Without Dordain, there would be no Ariane 6," he said.

Leroy said the decision to design an Ariane 6 with two liquid-fueled stages instead of a solid-fueled first stage "helps future-proof the vehicle and make it more adaptable. For example, any move to reusability, of the sort SpaceX is trying, would need liquid-fueled engines."

SpaceX currently charges about \$60 million for a single satellite launched on a Falcon 9. The Ariane 64 vehicle that appears on the verge of acceptance by European governments is expected to cost about 91 million euros to build and launch, leading to a price, in 2014 economic conditions, of 115 million euros (\$144 million) for a full vehicle with two satellites. The Ariane 6 vehicle, assuming its 4.3 billion euros in development funding is approved in December, is scheduled to be operational in 2020.

Neither Eutelsat nor ESOA appeared overly concerned about this price difference. Presented with a competitive challenge, de Rosen said, Europe's industry is likely to rise to the occasion.

Twitter: @pbdes

Email: pdeselding@gmail.com

## COMPROMISE FROM PAGE 1

upper stage and about 20 percent more power, is a much lower-risk endeavor and should be approved before any commitment to Ariane 6.

France had argued otherwise, first by proposing a solid-fuel-based Ariane 6 that found little support in industry or among commercial satellite fleet operators — the main customers for today's Ariane 5 — and then by aligning with a proposal by Ariane prime contractor Airbus Defence and Space and motor-maker Safran on Ariane 6.

The Ariane 6 comes in two models: an Ariane 62 that would be used mainly for government missions to medium and low Earth orbit, and a heavier Ariane 64 with solid-rocket boosters that would share technologies with the enhanced Vega rocket.

The new Ariane 6 program model, as described by ESA Director-General Jean-Jacques Dordain in an Oct. 29 response questions from Germany, would force industry to assume the risks associated with the commercial market, meaning no more annual government support payments to permit the launch services business to make ends meet.

In return, European governments would guarantee an average of five launches per year using Ariane, at set prices, to allow industry enough business to attack the commercial market on its own.

The new Ariane 6 approach thus represents a climb-down from the earlier positions held by both the French and German governments, and by ESA, whose governments

in late 2012 agreed to fund initial studies of the now-scrapped, solid-fueled Ariane 6 design.

The Ariane 6 rocket would be ready for an inaugural flight in 2020.

ESA has proposed to spend 8 billion euros (\$10 billion) in total on launchers between 2015 and 2024, including some 4.3 billion euros on Ariane 6, including a new launch pad at Europe's Guiana Space Center spaceport in French Guiana. The price support payments, which now average some 100 million euros per year, could continue until Ariane 6 is operational.

Zypries said Germany would insist that the 10-year commitment, which ESA has proposed be divided into payments to be released only after industry has reached certain milestones, be subject to a review at the next ESA ministerial conference, scheduled for 2016.

France has said it would finance 50 percent of Ariane 6's development. The German contribution is expected to be around 20 percent, with Italy and a handful of other ESA governments paying the rest.

With the key strategic issue now settled between France and Germany, governments and industry will focus on several outstanding questions related to Ariane 6. Among them: What happens if governments cannot maintain a five-per-year launch rate for their own satellites? Does industry then have a right to demand support payments as it battles Space Exploration Technologies Corp., also known as SpaceX, of the United States, Russia's Proton and other rockets on the commercial market?



Ariane 6

"Governance, meaning the share of risk between public and industry, needs some more work," Zypries said.

European governments have not yet firmly committed to maintaining their share

of international space station work through 2020, although they agree that 2020 is all but certain. Beyond 2020 — NASA wants to operate the facility through 2024 — is an open question.

In 2012 Germany agreed to increase its share of total European space station funding following the collapse of Italy's contribution in the face of the financial crisis in Italy. France also has hesitated on space station support, and German officials have said Germany will no longer provide a financial backstop for other nations' station roles.

Zypries said Germany, France and Italy, Europe's top three station backers, have reached an unwritten understanding that all of them will return to the space station percentage shares they agreed to in 1995 at an ESA ministerial conference in Toulouse, France.

"We underlined that the compromise includes the funding of the space station as the ESA executive has proposed, meaning the Toulouse key," Zypries said. "France and Italy did not object, which we take to mean that they have the same understanding."

The Italian-led ExoMars program, a two-launch mission in 2016 and 2018, meanwhile, remains short of needed financing by around 200 million euros. Zypries said no decisions were reached on this program, but that "Germany proposed to offer some in-kind contribution" beyond its agreed-to financial contribution level.

Twitter: @pbdes

Email: pdeselding@gmail.com



# NEWS BRIEFS

NEWS BRIEFS FROM PAGE 3

## LASP Finishes Ultraviolet Sensor For GOES-S Satellite

The Laboratory for Atmospheric and Space Physics (LASP) in Boulder, Colorado, finished an ultraviolet sensor slated to fly on a U.S. geostationary weather satellite launching in 2017, NASA said in a Nov. 13 press release.

The Extreme Ultraviolet and X-ray Irradiance Sensors (EXIS) instrument will fly on the National Oceanic and Atmospheric Administration's Geostationary Operational Environmental Satellite (GOES)-S satellite, the second in the GOES-R series slated to begin launching in 2016. NASA is managing procurement of the four GOES-R-series spacecraft, which are being assembled by Lockheed Martin Space Systems of Denver under a prime contract worth about \$1.4 billion.

LASP is building four EXIS instruments. The third, for GOES-T, is now undergoing post-environmental testing calibration, NASA said in its press release.

## Clinton-era Deep Space Climate Observatory Ships to Florida Launch Site, Finally



DSCOVR at NASA Goddard Space Flight Center in Maryland awaiting shipment to Florida

After spending more than a decade in storage, the Deep Space Climate Observatory (DSCOVR) — a Clinton-era satellite formerly known as Triana — arrived in Florida Nov. 20 for integration with the SpaceX Falcon 9 rocket set to launch it Jan. 23, the U.S. National Oceanic and Atmospheric Administration said in a press release.

DSCOVR uses hardware initially assembled for an Earth observation satellite conceived in the 1990s by then-U.S. Vice President Al Gore, earning the spacecraft the nickname Goresat. Resurrected by the Obama administration after the administration of President George W. Bush shelved the project in 2001, DSCOVR has been recast as a space weather mission and will head to Earth-sun Lagrange point 1 to keep an eye on charged particles blasting out of the sun.

The DSCOVR launch marks not only the end of a long wait on the ground for the erstwhile Goresat, but also the first Falcon 9 launch the U.S. Air Force has bought. The launch is costing the service \$97 million.

SpaceX of Hawthorne, California, formally known as Space Exploration Technologies Corp., won the DSCOVR launch in 2012 when Congress directed the Pentagon to open some military launches to companies other than incumbent government launch services provider United Launch Alliance of Denver.

DSCOVR will launch from Cape Canaveral Air Force Station, Florida.

# Earth and Life Sciences, Aircraft Ops Under Microscope in NASA Consolidation Effort

DAN LEONE, WASHINGTON

NASA's latest attempt to right-size its 10 U.S. field centers will begin with a focus on a roughly \$3 billion cross-section of the agency's nearly \$18 billion budget that could affect some 10,000 civil servants and contractors, a senior agency official said here Nov. 20.

Including administrative, clerical and support personnel, NASA employs some 17,000 civil servants — who by law may not be laid off — and between 34,000 and 40,000 contractors who work on or near the agency's field centers, Lesa Roe, NASA's deputy assistant administrator, told the NASA Advisory Council's (NAC) institutional committee during a meeting at NASA headquarters here. The latest meeting was only the second for the new NAC committee.

Roe, former director of NASA's Langley Research Center in Hampton, Virginia, is co-leading NASA's Technical Capabilities Assessment Team (TCAT) along with her boss, NASA Associate Administrator Robert Lightfoot. TCAT began in 2012 but will not be in full force until after February, when NASA plans to appoint so-called capabilities leaders to monitor its 10 field centers and point out areas where two or more centers are spending money on the same things.

Each leader will be in charge of one broad area of expertise NASA is calling a technical capability. There will eventually be 19 such agency-wide capabilities, Roe

told the NAC here, but NASA has so far identified only four: aircraft operations, Earth science research, life sciences research, and human factors — a discipline focused on making crewed systems such as spacecraft more user-friendly.

These four capabilities alone account for about \$2.8 billion of the roughly \$18 billion NASA spends a year and employ about 10,000 people, including contractors and civil servants, Roe told the NAC. There could be as much as \$550 million in annual savings to be had in these four areas, Roe told the NAC, although she acknowledged the number is "a target" NASA might not be able to hit.

Another target for savings under TCAT, Roe said, is mission operations. There are a total of 98 mission operations centers across NASA and the agency believes it can reduce costs in this area by about 30 percent, said Roe. The week of Nov. 10, NASA formed a team led by John McCullough, former chief flight director at the Johnson Space Center in Houston, to evaluate whether that target is realistic, Roe told the NAC.

In human spaceflight, Johnson has a practical monopoly on mission operations, with the Marshall Space Flight Center in Huntsville, Alabama, maintaining a backup mission control for NASA's international space station activities. But the dozens of planetary probes, Earth observation satellites and space telescopes NASA operates commonly are flown from dedicated mission operations



Lesla Roe

centers comprising no more than a few desktop computers.

Meanwhile, TCAT will also attempt to reduce the intra-agency infighting that sometimes occurs when centers vie for funds under competitive mission lines such as the Planetary Science Division's Discovery and New Frontiers programs, and the Astrophysics Division's Explorer program.

"We are spending ... quite a bit of money annually, competing for our own money, as an agency," Roe told the NAC. "We compete centers against each other,

and centers then hold on to capabilities we don't really need them holding on to just so they can compete. And that model has to be addressed."

One way centers hold on to capabilities outside of their core areas of expertise, Roe said, is through contractors. Certain capabilities, Roe said, should be consolidated at one center, with other centers using them as needed. An example of the model NASA would prefer, Roe said, is the agency-wide use of the Deep Space Network the Jet Propulsion Laboratory maintains to communicate with spacecraft beyond Earth orbit.

"No one will create new [Deep Space Network], they use the [Deep Space Network] we have," Roe said. "We need to do something like that for other assets."

TCAT is only the latest NASA attempt to reorganize its organizational footprint. Previous efforts have met with resistance in Congress, where lawmakers are always eager to protect NASA centers where their constituents work.

Roe acknowledged that telling the NAC that any TCAT recommendations, however sensible, will ultimately fail "if I don't align the budget in some way."

TCAT is not a secret on Capital Hill, and lawmakers so far briefed on the initiative are "very receptive to this," Roe said Nov. 20. "They think this is the right thing to do."



November 24, 2014

# British Company Announces Crowdfunded Lunar Lander Mission

JEFF FOUST, WASHINGTON

Hoping to leverage what it believes to be increased public enthusiasm for science and space exploration, a British company announced plans Nov. 19 to raise nearly \$1 million through crowdfunding to start work on a private lunar lander mission that will ultimately cost about \$1 billion.

Lunar Missions Ltd. is seeking to raise 600,000 British pounds (\$940,000) over the next month via the crowdfunding website Kickstarter to support studies of Lunar Mission One, a lunar lander mission planned for 2024 with both science and public outreach goals. The campaign raised more than 75,000 British pounds in its first 12 hours.

As currently proposed, the one-ton Lunar Mission One spacecraft will land on the rim of the South Pole-Aitken Basin, the largest impact crater in the solar system. The spacecraft's drill will collect rock samples from a depth of at least 20 meters, and potentially up to 100 meters, for analysis.

The spacecraft also will carry a "time capsule" that will later be buried in the hole created by the spacecraft's drill. That time capsule will include a public archive of information about humanity, but the company also plans to sell space in the capsule to individuals who want to include photos, videos or other digital messages.

The company believes those time capsule sales will provide the bulk of the funding for the mission. "We get members of the public to pay for the entire



▲ As currently proposed, the one-ton Lunar Mission One spacecraft will land on the rim of the Moon's South Pole-Aitken Basin, the largest impact crater in the solar system. The spacecraft's drill will collect rock samples from a depth of at least 20 meters, and potentially up to 100 meters, for analysis.

mission by giving them something that they want to buy," David Iron, founder of Lunar Missions Ltd., said in a Nov. 17 interview. He said the company's initial market research suggests there will be strong demand for access to the time capsule.

Iron said the company also will pursue corporate sponsorships for the mission but does not expect that to be a significant source of revenue. Government agencies also could be a source of in-kind funding for the mission,

he said, by supporting development of key mission technologies, such as the spacecraft's drilling system.

The company hopes to take advantage of what it sees as a surge of public interest in space, triggered in part by the recent success of the European Space Agency's Rosetta comet mission. "One thing that has been a big deal here is the Rosetta mission," Richard Holdaway, director of Rutherford Appleton Laboratory (RAL) Space, the mission's

technical adviser, said in a Nov. 17 interview. "The public has really been captured by the science in a way most of us didn't expect."

The company plans to emphasize the mission's science. "At the end of the day, this is primarily a science mission," Holdaway said. By drilling into the South Pole-Aitken Basin, he said, the spacecraft should be able to access rocks dating back to the origin of the solar system 4.5 billion years ago.

The Moon's south pole has

been of scientific interest for some time. The most recent U.S. planetary science decadal survey, prepared by the National Research Council for NASA in 2011, listed a sample-return mission to the South Pole-Aitken Basin as one of five high-priority medium-class missions that scientists recommended NASA should pursue through its New Frontiers Program.

Lunar Mission One will not return samples, but Iron said the spacecraft could have the ability to cache rock samples collected by its drill for return to Earth on a future mission.

Lunar Mission One also is one of the largest space-related crowdfunding initiatives to date. In 2013, Planetary Resources Inc. raised \$1.5 million through Kickstarter to fund development of a space telescope. In June, the student-led Time Capsule to Mars project announced plans to raise most of its estimated \$25 million cost through crowdfunding.

One risk Iron acknowledged is the all-or-nothing nature of the Kickstarter crowdfunding platform: The company will receive money only if it meets or exceeds its 600,000 British pound goal. However, Iron was not worried about falling just short of its goal and thus not receiving any money.

"It's possible, but we don't think it's likely" that the company will just miss its fundraising goal, he said. "We think we will either fail completely or succeed completely."

Twitter: @jeff\_foust  
Email: jfoust@spacenews.com

## Airbus Awarded ESA Contract To Build Service Module for Orion Capsule

PETER B. de SELDING, PARIS

The European Space Agency on Nov. 17 signed a firm, fixed-price contract with Airbus Defence and Space for the construction of the service module for NASA's Orion crew transport capsule, with a launch set for late 2017 or early 2018.

Under the contract, valued at 390 million euros (\$488 million), Airbus will design and build one service module and build parts for a second to acquit ESA of its space station maintenance dues to NASA between 2017 and 2020.

The Orion service module, which provides propulsion, power, thermal control and elements of the life-support system for Orion, is based on ESA's Automated Transfer Vehicle (ATV) cargo freighter. ESA had been reimbursing NASA for Europe's 8 percent share of space station common operating charges by launching five ATV vehicles, which paid Europe's station bills until 2017. The Orion service module completes this obligation through 2020.

ESA and NASA have evaluated ESA's annual dues at around 150 million euros.

The two agencies have said they hope to extend the Orion partnership beyond a



▲ The Orion service module, derived from Europe's Automated Transfer Vehicle, sits directly below Orion's crew capsule.

first unmanned flight. But for now, ESA has been unable to secure its member states' commitment to the station beyond 2020 — and even 2020 is subject to final approval.

The NASA-ESA Orion agreement stops at provision of hardware for a second service module, which could be assembled

in the United States by a U.S. contractor in the event the agreement is not extended.

ESA governments are scheduled to meet Dec. 2 to formalize their commitment to station operations to 2020 and to complete the financial backing needed for the Orion service module. At their last meeting, in late 2012, they agreed to commit 55 percent of the service module's cost, with the remaining portion conditioned on a longer-term agreement among ESA nations on space station operations.

The contract signed with Airbus includes protections for ESA and for Airbus in the event — considered highly unlikely — that ESA governments do not agree to space station support to 2020.

ESA has pegged its Orion service module budget at around 470 million euros in 2014 economic conditions, meaning after accounting for inflation since 2011. It has spent around 80 million euros in the past two years to get to the service module's preliminary design review, which is expected to conclude in the coming weeks.

A detailed critical design review is expected by late 2015, with flight-model construction to begin and then delivery to NASA.

ESA managers are planning to ask

their governments for 800 million euros in station support at the Dec. 2 meeting, with the remaining 200 million euros needed to operate the facility to 2020 to be requested at a meeting of ESA governments in 2016.

"The fact that we now have a firm, fixed-price contract with industry should send a positive signal to our governments meeting on Dec. 2," said one official involved in Europe's space station program.

The German government, which is Europe's biggest space station supporter, is demanding that France and Italy, whose financial support has softened, return to their previous levels of contribution instead of assuming Germany will cover any shortfall. Germany wants to cap its contribution at 37.7 percent of the total, in keeping with an agreement reached in 1995.

Neither France nor Italy has confirmed its space station budget to 2020.

For the Orion service module, Germany heads a list of contributors that include, in order, Italy, France, Switzerland and Belgium.

Twitter: @pdes  
Email: pdeselding@gmail.com



November 24, 2014

# SES Casts Its Vote in Inflight Internet's Battle of the Bands

PETER B. de SELDING, PARIS

Satellite fleet operator SES, saying the aeronautical communications market "is one of the biggest opportunities we've seen for years in the satellite business," has concluded that Ku-band is superior to Ka-band for most mobile-broadband applications.

Stepping into a debate being played out as hundreds of commercial aircraft are outfitted with Ku- or Ka-band terminals, Luxembourg-based SES said using the latest frequency-coding techniques, wide Ku-band beams over little-trafficked areas coupled with high-throughput Ku beams for dense routes, offers better value for most customers than a Ka-band network.

Ka-band satellite capacity has been deployed in Europe and North America for consumer broadband, mainly for a stationary customer base, using multiple spot beams that direct concentrated energy over a relatively small area and permit the reuse of the spectrum.

For this kind of application, SES said, Ka-band may well be superior. But for mobile applications, especially over low-density routes, a wide Ku-band beam covering a large swath of territory "can offer very competitive Mbps [megabits per second of throughput], similar to [high-throughput satellites]," said Simon Gatty Saunt, SES's vice



SES's Simon Gatty Saunt said that for mobile applications, especially over low-density routes, a wide Ku-band beam covering a large swath of territory "can offer very competitive Mbps [megabits per second of throughput], similar to [high-throughput satellites]."

president for Europe, data and mobility.

"Wide beams are well-suited to accommodate traffic growth by gradual capacity increases [and] provide improved economics for low-density and starter routes," Saunt said in a Nov. 13 SES webcast.

SES is one of many satellite fleet operators looking for pockets of growth as their core television broadcast markets mature. Aeronautical mobility, offering broadband connections to aircraft cockpits, crews and passengers, is viewed as finally beginning its long-promised

hockey-stick-shaped growth phase.

There is no clear verdict on which airline business model — free service with the costs embedded in the airline ticket or a pay-per-megabyte or pay-per-flight model — will gain the most traction among airlines.

ViaSat Inc. of Carlsbad, California; Eutelsat of Paris; Intelsat of McLean, Virginia; Telesat of Canada; Thaicom of Thailand; SES; and others are building satellites with mobility beams.

ViaSat and Eutelsat are combining their current and future

Ka-band systems to offer what is designed to be a seamless Ka-band access route covering Europe, North America and the North Atlantic air corridor.

Intelsat, Telesat and SES are adopting the frequency-reuse, concentrated-beam architecture of Ka-band systems in Ku-band, taking advantage of Ku-band's better resistance to precipitation and the fact that they already use Ku-band for direct-to-home television.

Saunt said that some Ka-band high-throughput satellites (HTS) offer compelling per-megabit throughput costs, but that this advantage disappears in the total cost of system ownership. "Ka-band equipment — the antenna and the [solid-state power amplifier] — is much more expensive than Ku," Saunt said.

ViaSat and other builders of Ka-band systems say that the cost difference in ground gear is disappearing fast as Ka-band systems are deployed and scale economies are generated.

Gez Draycott, SES's senior manager for satellite engineering, said during the webcast that SES remains "bandwidth agnostic. We use C- and Ku-bands and we are developing Ka-band satellites as well."

But managing aeronautical customers with a high-throughput satellite with dozens of spot beams requires multiple ground gateways, which add operating costs

and complexity to the system, Draycott said. "Capacity reservation on multiple beams is necessary, because not all beams will be hot spots," he said.

Draycott used the example of a flight from London to Sofia, Bulgaria. To provide full coverage for the flight, a satellite fleet operator with a Ka-band spot-beam satellite likely would need 10 beams for full coverage as the plane moves from gateway to gateway, each with its own IP address.

As a general rule, Draycott said, a Ku-band HTS spot-beam satellite will have beams between 550 and 965 kilometers in diameter, while a similar Ka-band satellite's beams would be around 480 kilometers in diameter. A wide Ku-band beam covers an entire continent.

SES said a Ku-band HTS system beam typically can offer 200 megabits per second on the forward link and 80 megabits per second on the return path. For Ka-band, the company said, the downlink is 45 megabits per second, with the return link at 4.5 megabits per second.

"A plane traveling at 500 miles per hour [805 kilometers per hour] would be in a given beam only for 45 minutes before it would need to switch," Draycott said. "This technical complexity adds a lot of extra risk to the service."

Twitter: @pbdes

Email: pdeselding@gmail.com

## U.S. Air Force Maps Out Next Steps with Protected Tactical Waveform

MIKE GRUSS, WASHINGTON

The U.S. Air Force is expected to demonstrate its newly developed protected tactical waveform in new modems and reworked terminals as early as 2018 as part of a long-term strategy to bolster the service's ability to offer protected communications using either military or commercial satellites.

According to slides accompanying a Nov. 5 presentation by Deanna Ryals, chief of the International Military Satellite Communication Office at the Air Force Space and Missile Systems Center in Los Angeles, the service plans to issue a request for proposals in January for modems that could be integrated into the terminals currently used with the Air Force's Wideband Global Satcom satellites.

In theory, the new modems could be swapped out with modems on existing WGS and commercial terminals to process the protected tactical waveform, a far less expensive option than building new terminals. Air Force officials have said terminals are the most costly element of military satellite communications programs.

The Air Force expects to award a contract for the modems during summer 2015 and conduct over-the-air field demonstrations in 2018 and 2019, according to

the slides, which accompanied a presentation by Ryals at the Global Milsatcom Conference in London.

Facing rising demand for satellite bandwidth and a growing problem with signal jamming, the Air Force has funded a series of tests to evaluate alternatives for dramatically lowering the cost of delivering secure services via both commercial

and El Segundo, and Space Systems/Loral (SSL) of Palo Alto, California, are among the companies that received study contracts under the initial part of the effort, which according to the slides has been largely completed.

The next round of studies is aimed at informing an Air Force decision on an "affordable family of systems" that

terminals over both WGS and commercial satellites in 2018, the slides said.

Boeing announced Nov. 4 a successful test involving the transmission of data from a Boeing-built ground terminal and programmable modem to a satellite simulator and then to a second terminal built by Lincoln Labs. Boeing said the test demonstrated the waveform's compatibility with different terminal platforms.

In a Nov. 6 interview, Boeing executives said the level of protection was similar to that provided by the tactical payloads aboard Advanced Extremely High Frequency satellites. Contractors on the Advanced Extremely High Frequency system, which also is designed to provide nuclear-survivable communications to strategic forces, have disputed similar assertions in the recent past.

"We've confirmed this technology can be applied quickly and affordably to existing assets, especially operational WGS satellites and ground terminals," Dan Hart, vice president of Boeing Government Satellite Systems, said in the press release. "With threats to secure communications becoming increasingly frequent and sophisticated, providing this enhanced capability to warfighters on the ground is critical."

**"We've confirmed this technology can be applied quickly and affordably to existing assets, especially operational WGS satellites and ground terminals."**

Dan Hart

and military satellites. Although the Air Force operates a highly secure satellite system, dubbed Advanced Extremely High Frequency, most military communications traffic is handled by WGS and commercial satellite systems, both of which are vulnerable to jamming.

Boeing Space & Intelligence Systems of El Segundo, California, Intelsat General Corp. of Bethesda, Maryland, Raytheon Space and Airborne Systems

would support the protected tactical waveform, Ryals' presentation slides said. These systems would operate over WGS, Defense Department free-flyer satellites — these have been described by Air Force officials as relatively small satellites with limited, single-payload missions — and commercial satellites, the slides showed.

The Air Force hopes to demonstrate the transmission of the protected waveform via production-representative

Twitter: @Gruss\_SN

Email: mgruss@spacenews.com



November 24, 2014

# SPOTLIGHT

CLYDE SPACE LTD.



## Small Satellites, Big Opportunities

DEBRA WERNER, SAN FRANCISCO

In 2015, Scotland's Clyde Space Ltd. plans to work with an unnamed U.S. company to establish a joint venture in the United States, a move that would extend the reach of the rapidly growing manufacturer of small satellites and spacecraft systems.

"We are having discussions with another organization about moving into the United States so we can be closer to our U.S. customers," said Craig Clark, Clyde Space founder and chief executive.

Under the proposed plan, one or more U.S. entities would own a majority of the new firm, which would be staffed by U.S. citizens. That setup would enable the firm to compete for any U.S. government or commercial contracts that are restricted to U.S. companies.

Clyde Space already works with some U.S. government agencies. The firm supplies solar panels and reaction wheels for the U.S. Air Force Academy's FalconSat-6, a satellite scheduled to launch in 2016 that is designed to demonstrate advanced propulsion technologies and spacecraft subsystems.

"I've always had a good relationship with the Air Force Academy, the Air Force and other U.S. government organizations,"

Clark said. "The U.K. and U.S. have a very good relationship with a lot of trade moving in both directions."

Nevertheless, it makes sense for Clyde Space to establish an affiliate in the United States, according to John Wardlaw, investment director for Coralinn Private Equity of Livingston, Scotland, which owns slightly more than 28 percent of Clyde Space.

"A big part of the global space market is based in and around the United States," Wardlaw said. "Clyde Space does a lot of business in the United States and with U.S. companies. We are getting to the time when we need to have a more formal presence in the United States."

The U.S. market for small satellites and subsystems is expanding rapidly. San Francisco-based Planet Labs Inc. has launched 71 cubesats. Spire, also of San Francisco, plans to launch at least 50 cubesats. Google Inc. entered the fray with its June announcement that it purchased Skybox Imaging, a firm based in Mountain View, California, that is launching 120-kilogram satellites to provide high-resolution Earth imagery, and on Nov. 10 Elon Musk, founder of Space Exploration Technologies Corp., tweeted, "SpaceX is still in the early stages of developing advanced micro-satellites



PHOTO BY ARCHIBALD PHOTOGRAPHY LTD.

Craig Clark with UKube-1

### Clyde Space Ltd. at a Glance

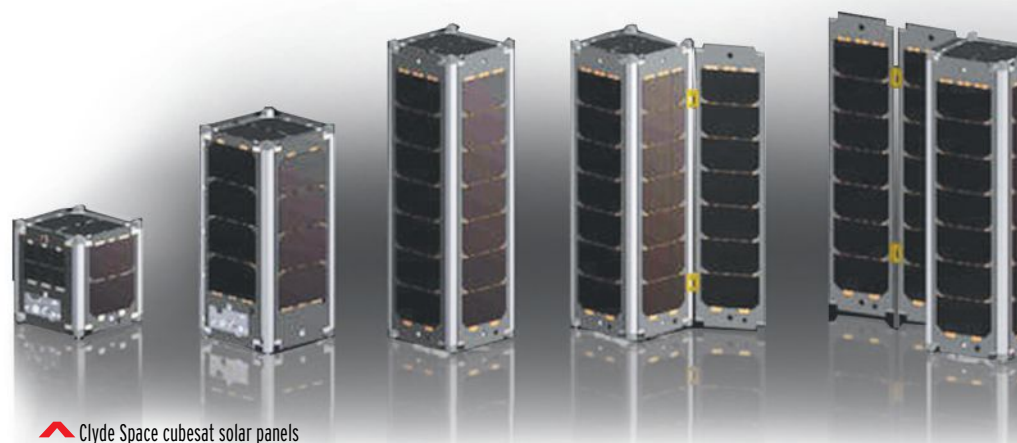
**Established:** 2005

**Location:** Glasgow, Scotland

**Top Official:** Craig Clark, founder and chief executive

**Employees:** 40

**Mission:** Pushing the utility envelope of microspacecraft for the benefit of future commercial and science missions for Scotland and beyond.

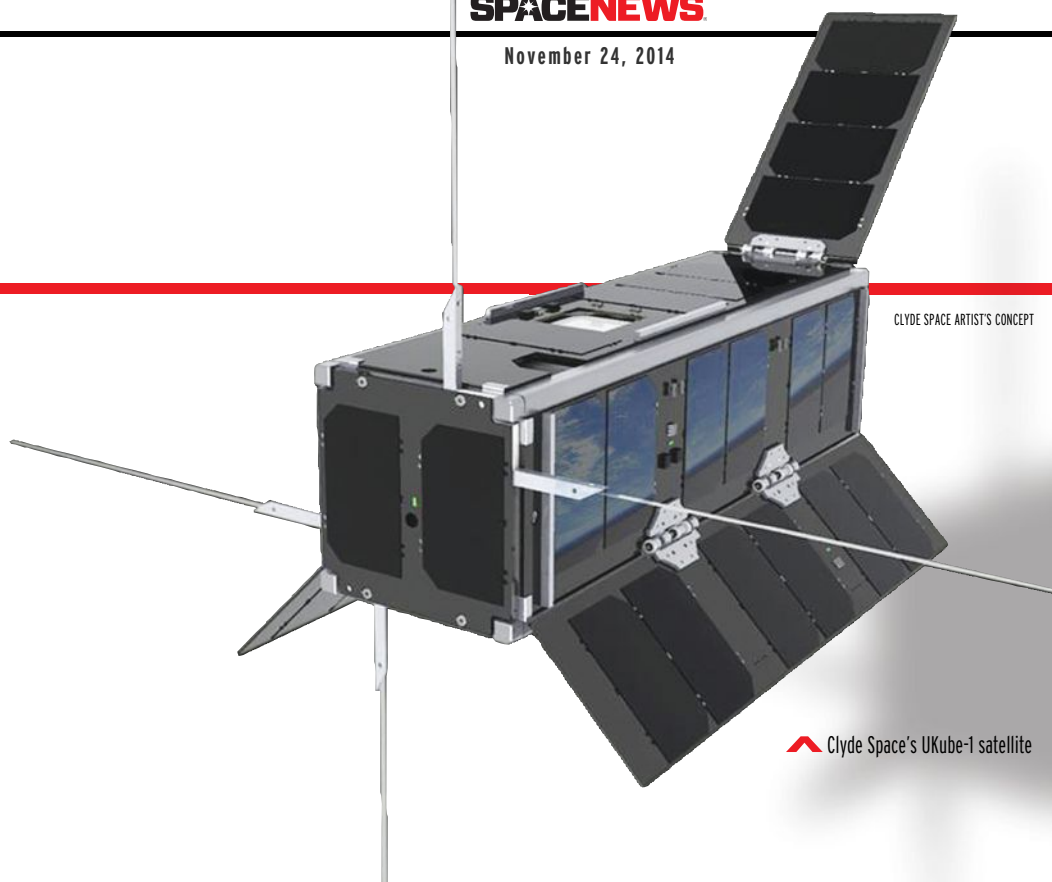


CLYDE SPACE PHOTO

Clyde Space cubesat solar panels



November 24, 2014



CLYDE SPACE ARTIST'S CONCEPT

Clyde Space's UKube-1 satellite

operating in large formations.”

The growing popularity of spacecraft constellations is helping Clyde Space because customers are placing large orders and repeat orders, which enables the company to reduce costs.

“We are moving to bulk manufacturing now, producing power systems and batteries in quantities of 100,” Clark said. “I expect that will move to 200, 300 or even 500, which will help us drive our price down but keep the quality at the same level.”

Clyde Space's business has expanded steadily. In the last five years, demand for the firm's products has surged an average of 40 percent per year. On Oct. 27, Clyde Space reported record profits of 2 million British pounds (\$3.1 million), compared with 1.1 million pounds the previous year. At the same time, the firm announced a contract valued at 1.2 million pounds with LuxSpace of Luxembourg to supply power systems for two European Space Agency satellites and a 940,000-pound contract to build power systems for Spire.

Increasingly, Clyde Space is building entire cubesats in addition to components. UKube-1, launched in July, was the firm's first complete cubesat and the first satellite designed and built in Scotland. Clyde

Space is building another cubesat for the Belgian Institute for Space Aeronomy. “We are effectively acting as prime for that contract, not only designing, integrating and testing, we are doing all the operations as well,” Clark said.

Moving from building cubesat components to complete platforms was a natural progression. “We sell all of our component parts for spacecraft for a price that is affordable for universities as well as other organizations,” Clark said. “Because we assembled the one spacecraft and are already working on the next spacecraft, it means that we know how to integrate our products into a complete system. That allows us to add more value.”

Within five years, Clyde Space plans to produce 1,000 complete cubesats per year. “We want to be the No. 1 company in the world for cubesats,” Clark said. “We will have a production line for cubesats. I think that's where the market is going.”

Clark expects the cubesat market to expand rapidly as military, commercial and scientific organizations identify a variety of missions that could be accomplished with 100 orbiting cubesats equipped with sensors. “If there are 10 missions each with 100 cubesats, that's 1,000 right there,” Clark said. “I imagine there will be a lot more than 10 missions. We are at such an early stage in our market.”

Clyde Space is preparing for that market growth by bolstering its staff with continual hiring. The firm also is moving to a larger facility. On Nov. 28, Clyde Space plans to move within Glasgow to a 1,000-square-meter facility, three times the size of its current office. “We've run out of desk space,” Clark said. “That is a problem for recruitment because we need more staff and we've nowhere to put them.”

Comments: [werner.debra@gmail.com](mailto:werner.debra@gmail.com)

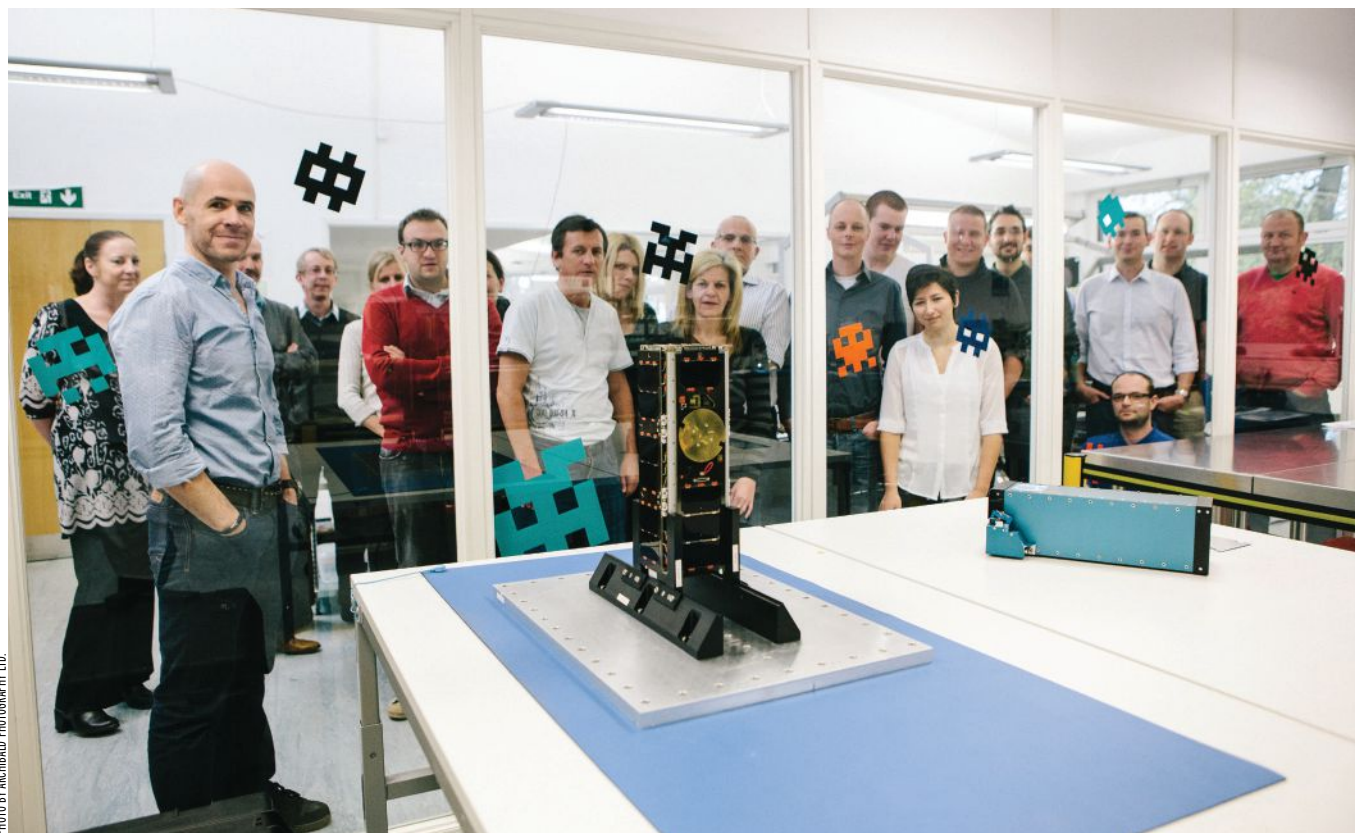
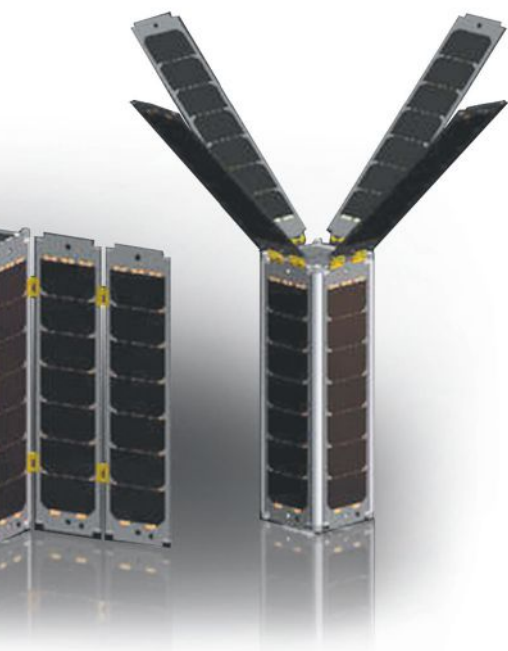


PHOTO BY ARCHIBALD PHOTOGRAPHY LTD

On Nov. 28, Clyde Space plans to move within Glasgow to a 1,000-square-meter facility that is three times the size of its current office. “We've run out of desk space,” said Clyde Space Chief Executive Craig Clark (second from left). “That is a problem for recruitment because we need more staff and we've nowhere to put them.”



November 24, 2014

# Japan's NEC Looks To Expand Commercial Market Footprint

PAUL KALLENDER-UMEZU, TOKYO

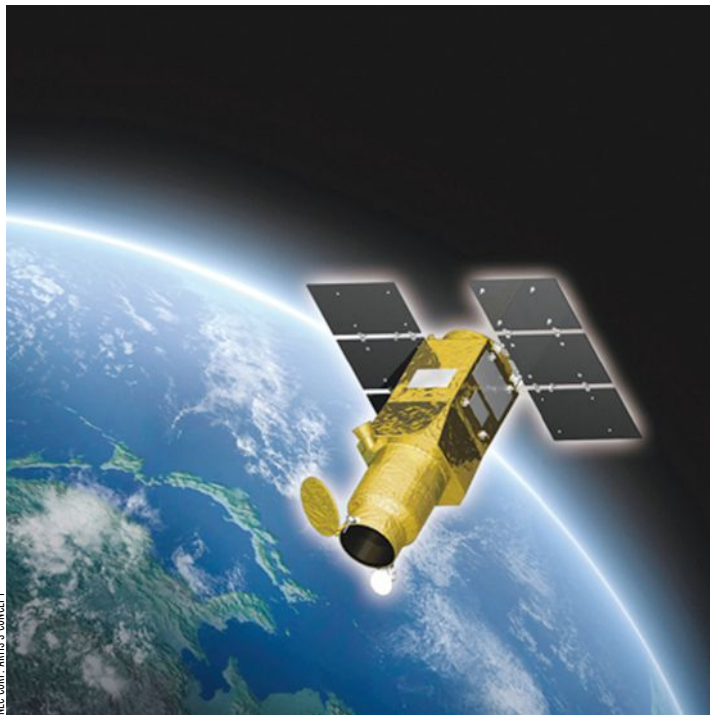
The Nov. 6 launch of the first of a new generation of low-cost Earth observation satellite platforms built by NEC Corp. for the Japanese government comes as the company looks to make further inroads in the international commercial market with a range of satellite offerings.

After a lengthy delay, the inaugural Advanced Satellite with New System Architecture for Observation, or ASNARO-1, was successfully launched aboard a Russian Dnepr rocket from that country's Yasny launch base, Japan's Ministry of Economy, Trade and Industry (METI) said. The 450-kilogram satellite is primarily a demonstration platform but carries an optical sensor capable of taking images with 50-centimeter resolution.

The ASNARO program is part of a broader Japanese government bid to refocus its space program on practical applications, in this case through a low-cost but highly capable platform for optical and radar Earth observation.

Tokyo-based NEC already has sold two ASNARO-based radar satellites to Vietnam and is looking to more fully ensconce itself in the commercial market. The company's components have been widely used in a variety of space missions, but until the Vietnam deal its business as a satellite prime contractor has been limited almost exclusively to the Japanese government market.

"Government space policy has changed to actively supporting



▲ Tokyo-based NEC already has sold two ASNARO-based radar satellites to Vietnam and hopes to build on that success with a broader set of commercial market offerings.

industry and not just" research and development, said Toshiaki Ogawa, NEC executive specialist for space business. "We think now is the time to spread our market commercially."

The company is marketing a 300-kilogram, ASNARO-based satellite platform called the NX-300L that Ogawa said will be attractive to emerging countries looking to deploy their first space assets. "The NX-300 has very high performance for a 300-kilogram bus and has very low power requirements, fast data rates, is very

flexible and offers a lot of features for an affordable price," he said, declining to elaborate.

NEC also is offering a larger Earth observation platform dubbed the NX-1500L and soon will be offering the NX-G, a relatively small platform for geostationary communications missions.

The NX-1500L, weighing 1000 to 1,500 kilograms, is based on the Global Change Observation Mission-Water satellite, also known as Shizuku, that NEC built for the Japan Aerospace Exploration Agency and launched in May 2012

aboard an H-2A rocket.

The NX-G will be a standardized commercial version of the 2.7-ton Wideband InterNetworking Engineering Test and Demonstration Satellite, also called Kizuna, launched in 2008, Ogawa said. Kizuna features advanced Ka-band payloads and can transmit data at rates up to 1.2 gigabits per second.

As is the case with the NX-300L, NEC is targeting emerging countries with the NX-G.

"The NX-G sales point is very clear," Ogawa said. "Although competing satellite manufacturers all offer big powerful buses in the 5-6 ton range with 10-20 kilowatts of power and some are even bigger, our focus is for 4-8 kilowatt satellites for emerging Asian or South American countries who don't need and can't afford such huge and powerful systems."

Ogawa said NEC will offer satellites in package deals that include communications, ground support and, in the case of Earth observation satellites, geospatial information products and services to help customers in developing countries make full use of the systems.

NEC has 40 years of experience building space hardware and ground systems. According to Masaki Adachi, general manager of NEC's Space Systems division, the company has supplied some 7,000 communications subsystems for more than 200 satellites.

"We have strong components sales and strong optical and communications technologies, and a design legacy. We aim to double

our annual space-related revenues from about 50 billion yen now to 100 billion yen in 2020," Ogawa said.

In June, the company opened a satellite manufacturing facility in Fuchu City, west of Tokyo, that will enable it to build and test eight satellites simultaneously, or double its previous capacity. The 9,000-square-meter facility was funded by a 9.6 billion yen (\$82 million) NEC investment following a 2 billion yen subsidy from the government.

The decision to target the commercial market comes at a time when the Japanese government is aiming to increase spending on space.

NEC is a prime candidate to build a high-data-rate laser optical communications satellite that the government would use for data from its growing fleet of Information Gathering Satellites and planned maritime surveillance constellation. NEC also is the ground systems and services provider for the Quazi-Zenith regional navigation satellite system, which also is being expanded, and is integrating two geostationary X-band military communications satellites for the defense ministry.

"The Japanese government policy is now investing more in space technologies that are useful for commercialization, and now is a good time for NEC to invest," said Masaru Uji, general manager at the Society of Japanese Aerospace Companies.

Email: paul.kallender@newstandardjapan.com

## Canada's MDA Devising New Methods To Track Ships Not Using AIS

DAVID PUGLIESE,  
VICTORIA, British Columbia

MDA Corp. will over the next six months find new methods to combine the use of radar and optical satellites to track so-called dark ships — vessels that are not broadcasting Automatic Identification System (AIS) signals.

The goal of the new research program is to better coordinate the two types of satellites, which in some cases need days of notice in advance for an imaging mission, said David Belton, vice president of Geospatial Services for the Richmond, British Columbia-based company.

"We're doing research where multiple satellites and sensor technologies can be used more efficiently to plan and collect data for the purposes of detection of vessels that aren't broadcasting AIS information," he explained.

All ships above a certain weight class are now required to carry AIS packages that transmit information such as their position and heading. Satellites are used to relay that data to coastal authorities. Dark ships are vessels that are required to broadcast AIS signals but do not.

Belton said the problem of dark ships, also known as dark targets, is significant

in some areas; one analysis of maritime traffic in the Mediterranean Sea indicated that upward of 50 percent of vessels in that body of water fell in the dark target category. Similar problems with such vessels exist in Southeast Asia, he added.

The plan would be to use radar satellites to do broad area imaging to get general patterns of marine traffic. Optical imagery satellites would provide coverage of a much more specific and smaller area, such as choke points.

Belton said one of the main challenges of using commercial satellite imagery for such a task centers on the time lines required to get imaging plans in place. That can take anywhere from 12 hours to seven days, which hinders a rapid turnaround for such information.

"The goal of the research is to come up with algorithms and some heuristic rules of how to most efficiently combine two sensors together to accomplish that coverage goal," Belton said. "Different missions have different characteristics, different orbits, different swath widths, so we'll be looking at what is the most efficient way to pair Radarsat 2 data with RapidEye coverage as an example. Or the most efficient way to pair Radarsat 2 with TerraSar and COSMO."

But Belton said the effort is not aimed at undercutting AIS information providers

such as Com Dev's exactEarth. Such data are needed, he said.

"I don't think it's a shot over their bow — exactEarth is a core data feed we use to support our service," Belton said. "But the recognition of the maritime awareness people is that AIS is not enough because it only represents those ships who are choosing to self-broadcast. What we're offering is not a replacement of a capability in comparison to an AIS feed."

Belton noted that MDA currently has an existing product called BlueHawk that provides an unclassified multisensor maritime domain awareness picture to clients.

BlueHawk is available as an Internet-based service accessible through any Web browser, as a direct data feed into customer systems, or as an enterprise-class system installed at customer locations.

Belton declined to detail BlueHawk customers for proprietary reasons but said it is provided to international defense organizations, coast guards and border security organizations.

BlueHawk uses optical satellite imagery, employing RapidEye data, in a limited fashion, Belton said.

MDA wants to improve BlueHawk with its new research. Belton said he does not have a time frame on when improvements

might be made to BlueHawk because of the research into better use of optical and radar satellites but expects that lessons learned will be incorporated as soon as they are available.

"Our expectation is that as we learn more through this research and improve our knowledge base on how to collect with multisensors, those rules of thumb will role their way into our acquisition planning methodology," he said. "As the research is completed it will become one of the foundations of our sensor planning that feeds into the BlueHawk system."

The Canadian Space Agency (CSA) said it is also interested in the research, noting that the research "would provide great value to Canada in managing its maritime surveillance capability."

Belton said the CSA is eyeing the research for possible contribution to its proposed Radarsat Constellation Mission or RCM. RCM is a constellation of three radar-imaging satellites that will conduct maritime and Arctic surveillance. The first RCM spacecraft was originally scheduled for launch in 2014 but project delays has pushed that back to 2018.

RCM will also be outfitted with an AIS capability.

Email: dpugliese@shaw.ca



November 24, 2014

# Astra 2G Could Serve as Placeholder for Proposed Luxembourg GovSat

PETER B. de SELDING, PARIS

A commercial satellite owned by fleet operator SES of Luxembourg and scheduled for launch Nov. 28 contains a military Ka- and X-band payload that will help secure a Luxembourg-registered orbital slot reservation that otherwise expires in January, the Luxembourg defense minister said.

The Luxembourg government has a special interest in keeping the orbital slot because it plans to create, with SES, a joint-venture company to sell military satellite bandwidth to the NATO alliance and individual NATO governments and Luxembourg allies.

The project, called GovSat, has not yet cleared final approval with the Luxembourg government. SES's board of directors is scheduled to review it Dec. 4 on the assumption that by then the government go-ahead will have been given.

At that point, SES would select from among the prospective satellite prime contractors for GovSat. Bidders include Orbital Sciences Corp. of Dulles, Virginia, and Thales Alenia Space of France and Italy — both of which have specialized in relatively small telecommunications spacecraft.

In a document dated Nov. 4, Luxembourg Defense Minister Etienne Schneider makes the GovSat case, arguing that in addition to helping Luxembourg fulfill its NATO obligations in a way that brings benefits to Luxembourg, GovSat will tap into growing demand for military Ka-band and X-band capacity on satellites that have not been hardened to withstand radiation from nuclear explosions and thus are less costly to build and operate.

The document notably forecasts that the NATO alliance will be doubling the amount



Etienne Schneider argues that in addition to helping Luxembourg fulfill its NATO obligations, GovSat will tap into growing demand for military Ka-band and X-band capacity on satellites that have not been hardened to withstand radiation from nuclear explosions and thus are less costly to build and operate.

of military-frequency satellite capacity it wants at its disposal once its current contract, using British, French and Italian military satellites, expires in 2019.

The United Nations, the European Union and individual governments without their own military systems also should be steady GovSat customers, the document says.

The immediate priority is securing the orbital slot, whose location is not identified but whose reservation with international frequency regulators expires at the end of the year.

SES's Astra 2G satellite, built mainly to bolster existing

capacity for direct broadcast television into Britain and Ireland, will be used to "bring into use" the Luxembourg military satellite system by occupying the future GovSat slot for at least three months. That is enough, under current International Telecommunication Union rules, to preserve a reservation.

Once it has fulfilled this task, Astra 2G will be moved to its permanent location at 28.2 or 28.5 degrees east, one of SES's key TV broadcast orbital neighborhoods.

SES spokesman Yves Feltes on Nov. 19 declined to comment on the Schneider document, saying GovSat had not yet been given company approval, and referred

questions about the program to the Luxembourg government. It is unclear whether the GovSat partners have a backup in the form of a satellite already in orbit carrying the same military frequencies that could be stationed at the GovSat slot for the required three months.

The document details why Luxembourg, which is one of the European nations that have purchased access to the U.S. Wideband Global Satcom military X- and Ka-band constellation, wants to get into the military satellite operations business.

While WGS membership gives Luxembourg access to the entire WGS constellation on a pro rata basis, Luxembourg must seek U.S. military permission before loaning its WGS share to another nation — a sovereignty constraint.

Getting access to the British, French, Italian, Spanish or German military satellite communications networks directly or through NATO is a viable option, but access procedures are cumbersome and the capacity is expensive, the document says.

Commercial capacity is less costly and can be purchased on an as-needed basis, but civilian bandwidth is less secure and more subject to interference than military bandwidth, the document says. Demand for commercial capacity in crisis means governments must compete with broadcast networks, international organizations and others for beams over the crisis area.

The United Nations uses 350 megahertz of capacity on four commercial satellites spaced around the world, but U.N. officials would be receptive to switching to military bandwidth if it were affordable, the document says.

Assuming quick Luxembourg government approval, GovSat would be launched in 2017.

Asked by the government

to assess the project, the Luxembourg Chamber of Commerce highlighted the fact that NATO and the European Union have not yet made clear how much satellite capacity they want in the future, meaning GovSat includes a risk of softer-than-expected demand.

The Luxembourg government has agreed to purchase 100 million euros (\$125 million) in GovSat capacity over 10 years starting in 2017 to reduce project risks.

One of the unusual aspects of GovSat is that the joint venture company will ask customers to commit to restrictions related to the use of GovSat bandwidth to guide unmanned combat aerial vehicles.

The document is unclear about what international law currently says about combat drones, but the Luxembourg government realizes it has little hope of overseeing all uses of the bandwidth it sells to customers.

The government solicited outside legal opinion about its third-party-liability exposure if a drone strike was conducted using GovSat capacity. The conclusion: GovSat would not be liable so long as its customer contracts stipulate that the capacity must not be used in violation of international law.

One official said the Luxembourg governing coalition, which includes the Greens party, is already at pains to portray GovSat as a communications system and not a weapon.

Concerns about GovSat's use with drones rose in October when a Yemen national sued the German government, claiming a U.S. drone attack in Yemen that killed a family member was coordinated via satellite through the U.S. Air Force Base in Ramstein, Germany.

Twitter: @pbdes

Email: pdeselding@gmail.com

## Indonesia's PSN Switches to SSL after Boeing Unable To Pair Up All-electric Satellite

PETER B. de SELDING, PARIS

Indonesian satellite operator PT Pasifik Satelit Nusantara (PSN), after waiting a year for satellite builder Boeing to find a companion customer for a two-satellite contract for all-electric satellites to launch on a single SpaceX Falcon 9 rocket, on Nov. 19 said it had contracted with Space Systems/Loral (SSL) for the satellite.

In a joint statement, Jakarta-based PSN and SSL of Palo Alto, California, said the PSN 6 satellite will be launched in early 2017 aboard a rocket that SSL provided as part of the contract to operate at 146 degrees east in geostationary orbit.

One industry official said SSL is providing a SpaceX Falcon 9 launch. It was not immediately clear whether the launch would carry a second payload.

The SSL contract is one of several

ordered by Indonesian government and corporate operators in the past year. Orbital Sciences of Dulles, Virginia, is building a satellite for PT Indosat that is intended for the same orbital slot, 150.5 degrees east, as a satellite under construction by SSL for Indonesia's BRI bank.

Thales Alenia Space of France and Italy is building PT Telkom's Telkom 3S satellite, and PT Telkom has been weighing a decision on still another spacecraft, Telkom 4.

"Indonesia keeps you on your toes," one industry official said, referring to Indonesia's highly active, and complicated, satellite purchasing process.

El Segundo, California-based Boeing Space and Intelligence Systems had been trying to replicate with PSN what it achieved in early 2012 with two satellite operators, ABS of Bermuda and Satmex of

Mexico, now renamed Eutelsat Americas and owned by Eutelsat of Paris. The first of these two launches is scheduled to occur between January and March.

ABS and Eutelsat Americas each ordered two all-electric-propulsion satellites to ride in pairs on the Falcon 9 rocket built by Hawthorne, California-based SpaceX, formally known as Space Exploration Technologies Corp.

PSN wanted the same kind of deal, a way of keeping capital costs down given SpaceX's already low prices and the fact that sharing a launch with a co-passenger could mean a PSN 6 launch for less than \$35 million.

Boeing officials could not be reached for immediate comment, but industry officials have said since the breakthrough Boeing contract in 2012 that it is not easy finding two customers whose spending plans are so closely aligned as to permit

dual construction contracts and common launch dates.

Boeing officials have said one reason the company has not been able to repeat the two-satellite performance since 2012 is that some operators are waiting to see the new 702SP all-electric platform perform in orbit.

Replacing chemical propulsion with electric saves hundreds of kilograms in satellite launch weight, meaning potentially lower costs and, in the case of ABS and Eutelsat Americas, the ability to ride together on a Falcon 9.

The disadvantage of electric propulsion is that it takes months for its electric motors to power the satellite to final geostationary orbit, rather than a couple of weeks with chemical propulsion.

Twitter: @pbdes

Email: pdeselding@gmail.com



November 24, 2014

# COMMENTARY

&lt; EDITORIAL &gt;

## Cosmic Relief

### Comet Landing Was Just What the Doctor Ordered

The European Space Agency's landing of a spacecraft on a comet, a first for humankind, provided a welcome and refreshing break for a space community that recently has made global headlines for all the wrong reasons.

Like the October failures of Orbital Sciences Corp.'s Antares rocket and Virgin Galactic's SpaceShipTwo rocket plane, the successful touchdown Nov. 12 of ESA's Philae lander on the Comet 67P/Churyumov-Gerasimenko grabbed the attention of the general public. And with good reason: The degree of difficulty was such that the likelihood of failure was widely viewed as greater than that of success. That might explain the absence of key ESA government officials from events related to the landing.

But succeed it did in a sequence that was captured by a camera aboard the 3-ton Rosetta mothership that had brought Philae to the comet over a 10-year journey that covered some 6.4 billion kilometers. The tense moments leading up to the touchdown, and the relief and jubilation that followed, were reminiscent of NASA's landing, in August 2012, of a 1-ton rover on the surface of Mars using an unlikely looking contraption known as the Sky Crane.

The success cannot help but generate good will among ESA members on the eve of what could prove to be a landmark ministerial conference aimed at setting the agency's future priorities, on which key several members differ. News that France and Germany had come to terms on a future launcher strategy ahead of the meeting was a positive development in that regard, although one must assume that the timing in relation to Philae's landing was purely coincidental.

Of course, the landing did not go exactly as planned. While Philae originally touched down on its assigned spot on the

rocky comet, it failed to secure itself to the surface and effectively bounced, not once but twice, before finally settling down on a spot about a kilometer away. Unfortunately, that spot was in an area where sunlight is scarce, leaving Philae unable to recharge its batteries, which consequently ran out of juice some 57 hours later.

Philae was nonetheless able to collect a wealth of data — 63 hours' worth if its descent to the surface is included — which it was able to transmit back to Earth via Rosetta

to work with that should go a long way toward unlocking some of the longstanding mysteries surrounding comets, whose eccentric orbits around the sun make them visible from Earth for only brief periods of time. Already Rosetta and Philae have sent back stunning images of Comet 67P, and Rosetta will continue to chase and gather data on the object for another 18 or so months. There can be little doubt that the Rosetta mission will provide a new foundation for the scientific community's understanding of comets, notwithstanding Philae's truncated operations on the surface.

Here's hoping ESA's optimism that Philae can resume its science mission proves to be well founded. Even failing that, the mission has been successful both from a purely scientific point of view and for generating a global buzz beyond the friendly confines of the space community.

The lesson to be learned within the community is that when it comes to robotic exploration of the solar system, it always pays to aim high and take risks — within bounds of reason, of course. As with the NASA Curiosity rover's successful Mars landing, Rosetta and Philae have demonstrated that there's a perpetual — if occasionally elusive — pool of underlying public enthusiasm and support for challenging space endeavors that's there for the taking with the right combination of chutzpa, drama, science and skill.

**The mission has been successful both from a purely scientific point of view and for generating a global buzz beyond the friendly confines of the space community. The lesson to be learned within the community is that when it comes to robotic exploration of the solar system, it always pays to aim high and take risks — within bounds of reason, of course.**

before going into what could be a permanent hibernation mode. Much to their credit, ESA managers, who had scheduled Philae's data collection tasks based on the expectation that it would operate for much longer, were able to quickly reorder the agenda when it became apparent that the mission would be cut dramatically short.

ESA managers have since confirmed that the instruments that were activated operated as planned, although many questions — notably whether Philae was able to collect and analyze a Comet 67P soil sample — remain unanswered, at least for now. Agency officials are holding out hope that as the comet gets closer to the sun in the coming months its solar arrays will be able to capture enough sunlight to recharge its batteries, enabling more scientific data collection.

In the meantime, scientists will have plenty of fresh data

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## SPACENEWS

**Felix H. Magowan**  
Chairman  
[fmagowan@spacenews.com](mailto:fmagowan@spacenews.com)  
Tel: +1-303-443-4360

**William A. Klanke**  
President & Publisher  
[bklanke@spacenews.com](mailto:bklanke@spacenews.com)  
Tel: +1-571-385-0234

**Warren Ferster**  
Executive Editor  
[wferster@spacenews.com](mailto:wferster@spacenews.com)  
Tel: +1-571-356-9623

**Brian Berger**  
Editor, SpaceNews.com  
Deputy Editor, SpaceNews  
[bberger@spacenews.com](mailto:bberger@spacenews.com)  
Tel: +1-571-356-9624

### WASHINGTON OFFICE

1414 Prince Street  
Suite 300  
Alexandria, VA  
22314-2853 U.S.A.  
Tel: +1-571-421-2300

**News Editor**  
Todd Windsor  
[twindsor@spacenews.com](mailto:twindsor@spacenews.com)  
Tel: +1-571-356-9773

**Art Director**  
Lance H. Marburger  
[lmrburger@spacenews.com](mailto:lmrburger@spacenews.com)  
Tel: +1-571-356-9601

**Copy Editor/Web Producer**  
Clinton Parks  
[cparks@spacenews.com](mailto:cparks@spacenews.com)  
Tel: +1-571-356-9957

### Senior Staff Writer

Jeff Foust  
[jfoust@spacenews.com](mailto:jfoust@spacenews.com)  
Tel: +1-571-421-2300

**NASA, Policy**  
Dan Leone  
[dleone@spacenews.com](mailto:dleone@spacenews.com)  
Tel: +1-571-356-9531

**Military Space**  
Mike Gruss  
[mgruss@spacenews.com](mailto:mgruss@spacenews.com)  
Tel: +1-571-356-9022

### PARIS OFFICE

**Paris Bureau Chief**  
Peter B. de Selding  
[pdeselding@gmail.com](mailto:pdeselding@gmail.com)  
**Paris**  
6 Square Théophile Gautier  
75016 Paris, France

### Subscriber Services

Toll free: +1-866-429-2199  
Tel: +1-845-267-3023  
Fax: +1-845-267-3478

### CORRESPONDENTS:

**India**  
K.S. Jayaraman  
D-208 Jardine Block  
Brigade Gardenia Enclave  
J.P. Nagar 7th phase  
Bangalore 560078  
India  
[killugudi@hotmail.com](mailto:killugudi@hotmail.com)  
Tel: +91-80-2696-6579

**Israel**  
Barbara Opall-Rome  
51A Ben Yehuda St.  
Herzeliya 46403, Israel  
[opallrome@barak-online.net](mailto:opallrome@barak-online.net)  
Tel: +972-9-951-8258

### Kennedy Space Center, Fla.

Irene Klotz  
Kennedy Space Center  
Launch Complex 39 Press  
Site  
Kennedy Space Center, Fla.  
32899  
[iklotz@rocketmail.com](mailto:iklotz@rocketmail.com)  
Tel: +1-321-422-3431

**Japan**  
Paul Kallender-Umezu  
150-0002 Shibuya Ku  
150-0002 Tokyo-To  
Shibuya Ku  
Shibuya 1-20-17  
Mitake Hime 607  
Japan  
[paul.kallender@newstandardjapan.com](mailto:paul.kallender@newstandardjapan.com)  
Tel: +81-03-3499-0422

### San Francisco

Debra Werner  
180 29th Ave.,  
San Francisco, CA 94121  
[dlpwerner@gmail.com](mailto:dlpwerner@gmail.com)  
Tel: +1-415-412-5819

### Canada

David Pugliese  
[dpugliese@shaw.ca](mailto:dpugliese@shaw.ca)  
Tel: +1-250-592-8354



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# Time To Change a Poorly Crafted Law

&lt; TOMMASO SGOBBA &gt;

On Dec. 23, 2004, U.S. President George W. Bush signed into law the Commercial Space Launch Amendments Act of 2004 (CSLAA). Meant to promote the development of the emerging commercial spaceflight industry, the CSLAA made the Department of Transportation and the Federal Aviation Administration responsible for regulating commercial human spaceflight. It gave the FAA authority to regulate commercial human spaceflight safety only for the aspects of uninvolved public safety, but forbade FAA to levy any safety regulation for the safety of crew and flight participants onboard for a period of eight years, unless an accident happened before.

The CSLAA requires operators to provide prospective customers with written information about the risks of spaceflight and a statement of the fact that the U.S. government has not certified the vehicle as safe for carrying crew or spaceflight participants.

The rationale behind the CSLAA moratorium and subsequent extensions until October 2015 was to allow industry to acquire experience to create future regulations. The CSLAA moratorium is a gross mistake — not because it prevents the FAA from intervening, but because it does not require instead that industry develop its own initial safety program and rules.

Hardware and software can be designed to the best of our knowledge, but our knowledge is not perfect. We can apply the most rigorous quality control during manufacturing, yet perfect construction does not exist and some defective items will be built

and escape inspection. A “safe” system is essentially one that through the selection of additional margins, redundancies, barriers and capabilities (escape, for example) will “tolerate” (to a certain extent) hardware failures, software faults and human errors; mitigate harmful consequences; and/or lower the probability of their occurrence.

By not requiring industry to establish safety rules up-front, in line with the experience gained through government space programs, the unintended effect of CSLAA has been to encourage industry to set the

one of the most prolific aircraft designers of all time, with more than 140 designs spanning a 50-year career. During one class, Gabrielli commented on the crash of his G91 fighter prototype back in 1961 by saying that “every good airplane is smeared with blood.” Gabrielli was not a cynical guy; he was just expressing with crude words the approach of the early times of aviation, still in use in the 1960s: “Fly-Fix-Fly.” You design an airplane, build a prototype and fly it. You discover flaws through accidents, incidents or close calls; fix them; and keep

the U.S. Air Force developed a major safety standard, MIL-STD-882, establishing novel system safety engineering techniques and management concepts.

When North American Aviation developed the Apollo capsule in the 1960s, there was no safety program and no safety analysis was performed. A number of choices were made to optimize the mass of the vehicle. The early design used a pure oxygen atmosphere to lower the capsule internal pressure so that the shell could be made thinner and therefore lighter. A lighter inward-opening hatch was preferred to a heavier outward-opening design. Flammable thermoplastic materials were extensively used, and electrical wire bundles were made as light as possible by the choice of thinner, and therefore hotter, harnesses. The ingredients for a raging fire were all in place. On Jan. 27, 1967, during a ground test, a spark, probably caused by an electrical short circuit, triggered a fire. The internal capsule pressure rose, thus sealing the hatch and the three astronauts’ fate with it.

Modern safety analyses allow us to identify causes of potential accidents (called hazards) and to remove or mitigate them through the application of predefined best practices (e.g., safety rules like failure tolerance). Safety analyses and safety measures have been increasingly used over the last 40 years in government space programs, including in the development and operation of the international space station. Independent safety verification of correct implementation

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**The CSLAA moratorium is a gross mistake — not because it prevents the FAA from intervening, but because it does not require instead that industry develop its own initial safety program and rules.**

clock of its safety practices back to the early 1960s. The CSLAA may have planted the seeds of the first suborbital flight accident, the Oct. 31 fatal crash of Virgin Galactic’s SpaceShipTwo. The CSLAA allows companies to apply whatever level of failure tolerance they like in the design, without even requiring independent verification of the correct implementation.

In the early 1970s, I was a student of aeronautical engineering at the Politecnico di Torino in Italy, and I had the privilege of having as professor Giuseppe Gabrielli,

flying. At that time there was no other way: Safety programs and hazard analysis did not exist yet.

There was no safety program and no safety analyses were performed when the Atlas and Titan ICBMs were initially developed in the 1950s. Within 18 months after the fleet of 71 Atlas F missiles became operational, four blew up in their silos during operational testing. The worst accident occurred in Searcy, Arkansas, on Aug. 9, 1965, when a fire in a Titan 2 silo killed 53 people. As a response to those accidents,

## A New Capability for Suborbital Research and Education

&lt; ALAN STERN &gt;

Only a few years ago, suborbital research was limited to occasional, expensive rocket and balloon launches, largely using expensive Cold War technologies. Today, thanks to dedicated efforts by next-gen reusable suborbital rocket firms like Virgin Galactic, XCOR Aerospace and Blue Origin, the field is on the verge of a space access revolution that will dramatically lower prices, create orders of magnitude more frequent access to space, and allow researchers to fly with their experiments — further lowering the complexity, risk and cost of those very experiments.

At World View, we applaud the efforts of these suborbital rocket companies to open space access for the research and education market. We also applaud the efforts of government agencies like NASA to begin offering grants to researchers and educators to build and fly payloads aboard reusable, next-gen suborbital rocket vehicles. And we salute the research and education community’s deeply positive interest in next-gen suborbital research through attendance at conferences,

through proposal writing to win awards to fly on next-gen vehicles, and through the efforts within the Commercial Spaceflight Federation to foster this new field.

At the same time that reusable rockets are preparing to come on line to service research and education needs, we’re adapting our balloon-borne suborbital tourist vehicle, itself called World View, to be an effective, routine platform for the research and education marketplace in 2016-2017. We’re also putting in place smaller suborbital vehicles in our Tycho line that can carry research and education payloads into service earlier, beginning in 2015.

World View’s near-space access distinction is that our vehicles do not require rocket propulsion to reach high altitude. Instead, our vehicles use balloon technology capable of lifting payloads ranging from a few kilograms to a few metric tons to altitudes as high as 40 kilometers. At these altitudes — where the sky is black and Earth’s horizon is curved — important applications exist in a wide variety of research and education fields, including

atmospheric science, Earth remote sensing, instruction and astronomy. Important applications also exist for the in-space demonstration of systems, subsystems and sensors destined for orbit, i.e., “TRL (technology readiness level)-raising.” And a host of commercial surveillance, communications and entertainment opportunities present themselves at these altitudes as well.

While rockets and balloons are complementary tools that serve different functions in space access — just as are forks and spoons at the dinner table — there are many attributes that balloons can offer that no suborbital rocket can. These include:

- Gentler rides, so that payloads do not have to be designed and tested to withstand sustained high-acceleration G-forces during launch and entry, simplifying development and test challenges, and therefore also lowering costs for payloads and payload specialists.

- Longer flight durations, of hours (and even days) at altitude on balloons versus the minutes at altitude that currently envisioned next-gen suborbital rocket

systems offer.

- Lower altitudes, where both research and commercial applications can achieve higher ground resolutions, which are better suited, for example, to research in the crucial altitude regimes of the stratosphere.

- Greater range over Earth than rockets, which plan to fly back to their launch site and can’t traverse significant ground, air and space paths for research and education applications.

- An absence of zero-g, which in many cases creates unwanted research and education payload design and operational complexities. Avoiding zero-g simplifies development and testing and typically lowers the cost to fly both payloads and payload specialists.

- A lower cost of flight, which expands markets and widens opportunities for frequency of flight.

We believe these attributes will foster many new research and education applications in space, and we are proud to already be involved in demonstrating that in two important ways. First, we have placed three pathfinder payloads

under agreement to fly as research and education demonstrators on our Tycho and World View vehicles. These pathfinder payloads include in situ radiation monitoring, remote sensing imaging of the upper atmosphere to study its meteoroid environment, and an education payload centered on detecting the ozone layer. Second, we and our partner Paragon Space Development Systems have been recently awarded a NASA Flight Opportunities Program contract to provide flight services to NASA suborbital, near-space payloads during 2015-2017.

At Word View, we believe that suborbital research and education applications are as unlimited a green field now as personal computer applications were in the late 1970s.

*Alan Stern is a founder of World View and serves as chief scientist for the company. He is an experienced suborbital, Earth orbital and planetary mission researcher, the former chairman of the research and education committee of the Commercial Spaceflight Federation, and a former NASA associate administrator for space science. His email is [astern@worldviewexperience.com](mailto:astern@worldviewexperience.com).*



November 24, 2014

# The Future of Astronaut Activity

◀ MADHU THANGAVELU ▶

The astronaut corps is a unique group of people, handpicked from a wide range of scientific and technical professions, winnowed down through very rigorous selection methods, after which the select few are trained for complex space missions that involve a lot of risk, nail-biting and adrenaline at both the space crew and mission control ends. The human spaceflight crews at NASA, Russia's Roscosmos, the European Space Agency and the China National Space Administration are still considered the pinnacle of human and technological achievement and prestige in the world's leading spacefaring economies and their space agencies.

Many nations today aspire to join and participate in this exclusive club of advanced technology-savvy professionals who exude a unique kind of aura, a mix of skills, talents and yearning for high-wire drama. This select group of humans has seen the wholeness, oneness and richness of Earth from above, liberated from the air and gravity, completely free and floating, even removed from our earthly experience of night and day. They return to Earth as global ambassadors of sorts, with an expanded worldview and a refined sensitivity toward our planet's fragile biosphere.

Astronaut activity is a demanding endeavor in every aspect, requiring the physical and mental rigor, agility and dexterity of the crew, the interdisciplinary technologies and skillsets involved, organizational planning with seamless cross-cutting, the meticulous following of reliability and safety protocols, not to mention the monetary resources to back up and support development and operations that are essential for success. A flight task checklist alone runs into volumes of material, making one wonder how they accomplish all this during a short mission that lasts just a few weeks. Flight crew and mission control, impeccable teamwork and organization at its best, aided by agile technologies — this is what makes astronaut activity possible today.

But this effort has paid off handsomely across several other challenging national and global pursuits for those economies that have chosen to exercise it, applying the lessons learned in human space activity to

other complex endeavors here on Earth.

A recent, often-forgotten example occurred in 2010 when 33 miners were trapped deep underground in a Chilean copper mine. The Chilean government sought NASA's help, among others, to alleviate their misery and find ways to keep their morale up for the 10 weeks it took to extricate and bring them up safely, in a mission that taxed the deep isolation skills of human spaceflight professionals.

However, the past decade has seen some of the most drastic changes and adjustments in the various astronaut corps, including disproportionate budget cuts and rapid attrition in their numbers. And as private space industry and private spaceflight activity ramp up, including space tourism, government-trained astronauts are actively moving into newly created positions in this new arena, to create, supervise and evolve

and welding — and we are fast approaching the development of high-energy death rays for planetary protection and missile defense alike. Nanotechnology materials, precisely crafted by 3-D printers and laser technology to form metamaterials and shapes, may soon provide more efficient thermal and radiation protection for astronauts and may even be used to create nutritious, complex foods from simple chemicals.

High-fidelity simulations are a dependable way to test and ferret out issues and resolve them well in advance of mission deployment. NASA uses neutral buoyancy tanks to simulate astronaut activity in zero gravity. However, partial gravity conditions are hard to simulate on Earth, especially for the substantial periods of time that are needed to test full-up assembly or other construction activities. Virtual reality and gaming applications including massively

life-support systems, both vital technologies for long-duration missions.

Photovoltaics, the nonpolluting technology that converts solar energy into renewable power atop our homes, when coupled with high-density power storage systems, is already making compact and portable devices that are changing the way we live and work, from cellphones to emergency equipment in hospitals and in disaster management to warfighting machines and systems, and space missions are employing them regularly.

Many of these technologies are being evolved and employed routinely for innovation, research and development, not only in the national labs but also in universities and private companies and conglomerates, for profit.

Our romance with robots initially found a commercial home decades ago in the computer industry. Then they became an agent of change in the automobile industry and took over critical operations in heavy industry. Today robots are employed in expert systems for medical diagnostics and in delicate surgical procedures sometimes deemed too risky for the surgeon's trained hands. Nanotechnology-based products and allied systems are in the pipeline, already offering designer materials that may be suitable for space systems like astronaut suits and gloves, helmets and related critical life-support gear.

Will robots and robotic systems take over all space activity? Are they capable of all human tasks? Can they operate autonomously, without human support?

The answer seems to depend on the task at hand.

Professional explorers, prospectors and geologists alike seem to think robots can never replace humans. The rovers that are roaming the surface of Mars over 200 million kilometers away do many tasks by themselves but are supervised from mission control at the Jet Propulsion Laboratory in California. The Cassini spacecraft orbiting Saturn 1.5 billion kilometers away is given instructions and its systems tweaked in the same manner. And much closer to home,

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## Will robots and robotic systems take over all space activity? Are they capable of all human tasks? Can they operate autonomously, without human support?

new and more capable systems.

Despite these changes, and during this current period of loosely defined destinations and mission goals, a new generation of NASA astronauts is being trained for deep-space missions. And while these changes are afoot, leapfrogging technologies like robotics and communications are changing the landscape for future astronaut activity.

Fifty years ago, at the dawn of the Space Age, technologies were minted just to make spaceflight possible. But now, mature commercial technologies employed on Earth, from the prosaic to the profound, are finding their way into the astronaut's tool chest. These range from prospecting and mining to 3-D printing, ground- and altitude-based remote sensing and hyperspectral imaging, combined with adaptive optics and a range of laser-based applications, which include precision analyses of chemicals, separating minerals from ores, purification

parallel computer platforms operating on cloud networks, employing visualization headgear like Oculus Rift along with haptic feedback and tactile sensitivity, could be used to seamlessly mesh real subjects in various space and extraterrestrial environments, totally immersing astronauts in virtual mission environments with realistic visualization of partial gravity reaction scenarios. Supercomputers used to simulate nuclear explosions may be used, along with real radiation exposure data being gathered about Mars, to recreate whole body effects of interplanetary expeditions on crew and systems.

Synthetic biology and advances in genetics too may offer innovative ways to combat radiation damage to human tissue, which is a crucial concern, and techniques and processes from the biotechnology industry may find application in space agriculture and closed-cycle ecological

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is a daily activity for NASA and its international ISS partners, performed by interdisciplinary groups of experts, so-called safety review panels. Because of massive use of safety analyses in the ISS program, seven safety review panels are in place: four at NASA and three at international partner agencies.

On the contrary, the commercial human suborbital spaceflight industry has been making the point that no safety regulation should be levied in the "learning period" and no independent verification performed, stating that these would stifle progress and kill the business. More recently, the industry has asked to extend the learning period indefinitely. The media and the public seem to have generally supported this

position, possibly as a legitimate defense against utopian rules and red tape. But the risk here is wasted money and human lives just to reinvent the wheel.

During a February hearing of the U.S. House Science space subcommittee, George Nield, FAA associate administrator for space transportation, said that industry's plea for a longer learning period ignores government expertise about crewed space systems gathered by NASA's long-running human exploration program. It would be "irresponsible" to ignore the lessons from those programs and force regulators to collect a new set of data, Nield said.

Another bold message often echoed is that of the technological novelty and superiority of commercial suborbital vehicles compared with government programs. This

is just marketing.

Yes, space travel is a risky business and for that exact reason the most modern safety practices must be applied and continuously improved. Industry can propose rigorous self-regulation as an alternative to government regulation. The safety practices developed by NASA could be formally adopted as reference and further updated and improved as industry accumulates new experience and knowledge.

The International Association for the Advancement of Space Safety (IAASS) has published a collection of such heritage safety rules in a standard, available from our website (<http://iaass.space-safety.org/publications/standards/>). With the exemption of two quantitative safety goals, a crashworthiness requirement and

a data collection requirement, all safety rules in the IAASS standard are the same or similar to those applied in past and current government space programs, and by ISS commercial service vehicles.

No regulation is not a viable option. The return to the old-fashioned "Fly-Fix-Fly" approach can bring only the terrifying prospect of a stream of incidents and accidents possibly exhausting any residual public faith in the future of human spaceflight. Believing that space travel risks are forever inevitable, that substantial improvements are almost impossible, and relying on public acceptance of high levels of risk while society is increasingly risk-averse is a recipe for failure.

To paraphrase the finding of the U.S. Presidential Committee that investigated the Deepwater

Horizon oil spill disaster of 2010 in the Gulf of Mexico: The commercial human spaceflight industry must move toward developing a notion of safety as a collective responsibility. Industry should establish a "Safety Institute. ... an industry-created, self-policing entity aimed at developing, adopting and enforcing standards of excellence to ensure continuous improvement in spaceflight safety.

It is time to change the CSLAA of 2004.

*"A life without adventure is likely to be unsatisfying, but a life in which adventure is allowed to take whatever form it will is sure to be short."*

— Bertrand Russell

*Tommaso Sgobba is executive director of the IAASS. The views expressed are solely those of the author.*



November 24, 2014

# LaunchReport

NOVEMBER LAUNCHES

Date	Launch site	Vehicle and provider	Payload and owner	Outcome or purpose
Nov. 18	Taiyuan Satellite Launch Center, China	Long March 2C, China Academy of Launch Vehicle Technology	Yaogan 23, Shanghai Academy of Spaceflight Technology	Launched a remote sensing satellite.
Nov. 23	Baikonur Cosmodrome, Kazakhstan	Soyuz FG, TsSKB-Progress	Soyuz TMA-15M, Russian Federal Space Agency	To launch new crew members to the international space station.
Nov. 28	Baikonur Cosmodrome, Kazakhstan	Proton, International Launch Services	Astra 2G, SES	To launch a communications satellite.
Nov. 30	Tanegashima Space Center, Japan	H-2A, Mitsubishi Heavy Industries	Hayabusa 2, Japan Aerospace Exploration Agency	To launch an asteroid sample return mission.

DECEMBER LAUNCHES

Date	Launch site	Vehicle and provider	Payload and owner	Outcome or purpose
Dec. 4	Cape Canaveral Air Force Station, Florida	Delta 4 Heavy, United Launch Alliance	Orion EFT-1, NASA	To launch the Orion Multi-Purpose Crew Vehicle on an uncrewed test flight.
Dec. 4	Guiana Space Center, Kourou, French Guiana	Ariane 5, Arianespace	DirecTV 14, DirecTV; GSAT-16, Indian Space Research Organisation	To launch a direct-to-home television broadcast satellite and a communications satellite.
Dec. 7	Taiyuan Satellite Launch Center, China	Long March 4B, China Academy of Launch Vehicle Technology	CBERS-4, Chinese and Brazilian governments.	To launch a remote sensing satellite.
Dec. 10	Baikonur Cosmodrome, Kazakhstan	Soyuz, TsSKB-Progress	Resurs P2, Russian government	To launch a remote sensing satellite.
Dec. 11	Vandenberg Air Force Base, California	Atlas 5, United Launch Alliance	NR0L-35, U.S. National Reconnaissance Office	To launch a classified satellite.
Dec. 12	Baikonur Cosmodrome, Kazakhstan	Proton, International Launch Services	Yamal 401, Gazprom Space Systems	To launch a communications satellite.
Dec. 16	Cape Canaveral Air Force Station, Florida	Falcon 9, Space Exploration Technologies Corp.	SpaceX CRS 5, SpaceX	To launch a commercial resupply mission to the international space station.
Dec. 18	Guiana Space Center, Kourou, French Guiana	Soyuz 2-1b, Arianespace	O3b F3, O3b Networks	To launch four communications satellites.
December	Plesetsk Cosmodrome, Russia	Angara 5, Khrunichev State Research and Production Space Center	Maiden launch, Russian Federal Defense Ministry	To launch a heavy-lift rocket on a test flight.
December	Satish Dhawan Space Center, Sriharikota, India	GSLV Mark 3, Indian Space Research Organisation	Crew module prototype, ISRO	To launch the rocket on a suborbital test flight.
December	Plesetsk Cosmodrome, Russia	Soyuz 2-1b, TsSKB-Progress	Glonass K, Russian Federal Defense Ministry	To launch a navigation satellite.



A Chinese Long March 2C rocket launches the Yaogan 23 remote sensing satellite from Taiyuan Satellite Launch Center in China's northern Shanxi province.

XINHUA PHOTO BY YAN YAN



November 24, 2014

# MARKETPLACE



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the international space station has a humanoid robot called Robonaut 2 that is being tested and prepped to help the crew with their chores. It too is supervised from mission control. Detailed engineering studies have shown that complex projects like the last Hubble service and upgrade or previous satellite rescue missions could not have been accomplished by robots alone.

Advances in communication technology will allow wideband, teleoperated supervision of robots for complex assembly of large space structures and systems as well as closely coordinated co-robotic manipulations. For example, crew and robotic assistants working to build infrastructure in tandem in the same physical domain is an expanding area of investigation. This co-robotic approach is already seen as a natural and efficient extension of human capabilities in extreme environments here on Earth, and space activity provides another realm for expanding this application. One of the reasons for astronaut crew to be in the vicinity of action is to circumvent the time lag associated with operating a robot from Earth.

Depending on planetary positions, it takes between 8 and 45 minutes to send a command to the Mars rover and receive a signal back that it has executed the task, and it takes Cassini 2.5 hours to do the same. A lot of unintended things can happen over such long periods, especially when impromptu control is required for tasks that involve construction or other anomalous situations that may arise.

The future of human space activity in general and the niche arena of human space exploration that space agencies focus on today are fast approaching a synergetic and explosive growth period because investors see profit to be made in space activity — building orbiting solar power stations; enhancing communications platforms and maintaining that infrastructure; keeping track of and decommissioning old and failing stations by deorbiting them rather than mothballing them in graveyard orbits where they pose a potential debris hazard; and providing station-keeping fuel and propellants to outbound vehicles and other services including correcting the orbits of spacecraft in deviant or wrong orbits. It is well known among space architects and engineers alike that human supervision on site is essential for large and complex assembly and service operations in space in order to speedily resolve anomalies that may arise during execution.

Humans and robots together are ready to begin knitting space activity in our solar system into the mainstream of humanity's economic sphere of influence, making astronaut activity a routine part of our lives in which science and technology are integral to our culture, as much as progressive commerce and industry play a part in modern civilization.

Does the future hold peril or promise for our astronaut corps as we expand this enterprise? Peril, for space is the ultimate unforgiving environment, as it reminds us when things go wrong and we lose the brave men and women engaged in that exo-environment.

Nature never intended us in our fragile frames, evolved over a few million years, to live and work in space. Cocooned and nurtured on the mild surface of a watery world, blanketed by a thin but soothing atmosphere and shielded from the sun's wrath by an invisible magnetic field, we evolved in a biosphere like no other we know of. Even today, as we are freshly reminded, entering space, just escaping the clutches of Earth's gravity, requires complex and precision technologies and systems with extremely narrow tolerance for error.

And more peril too, for the 20th-century image of the government-employed astronaut who appears a daring suited figure, braving the extreme environment, all alone in the vast, silent and treacherous darkness of space. Even today, nearly 50 years since we began spacewalking, extravehicular activity is perhaps the most strenuous astronaut activity. The suits, once inflated, are cumbersome to work in, and the astronaut has to fight the stiffness of the suit and gloves to make normal movement possible. Like the capsule technology that is being superseded, the days of the Pillsbury Doughboy- or Michelin Man-shaped astronaut are numbered.

Hardsuits, or rigid suits molded from aluminum alloys, are being used in deep-sea diving missions today and may be adapted for space, employing tough and radiation-resistant materials like boron carbide to allow astronauts to move between spacecraft and the vacuum outside without the lengthy prebreathing protocol that is needed today to make the suits more flexible for movement.

This slow process allows the human body to adjust to the low pressure and altered atmosphere inside the suits without risking the bends, a condition where dissolved nitrogen in the blood may bubble out and cause severe painful problems and or even death. Strategies employing semi-rigid suits are proposed to allow gradual pressure reduction while crew members are being transported to the work site as well. A new generation of suits for extra-terrestrial activity on the Moon and Mars will effectively neutralize the threat posed by dust, especially on the Moon, that was quite debilitating to Apollo crew and rovers. Exoskeletal suits that help augment strength, combat fatigue and allow power amplification are being put to the test for soldiers in the battlefield and may also find application for the future astronaut. Meanwhile, the U.S. Defense Advanced Research Projects Agency is putting competing robot assistants to the test and offering prizes for winning designs.

And so there is promise for an entirely new vision of humans working alongside sophisticated robotic agents, as supervisors and directors and anomaly resolvers. They will be comfortably nested in cabins within spacecraft in a shirt-sleeve environment, teleoperating swarms of robots, building huge solar power satellites and assembling massive spaceships from materials dug up and processed among the asteroids, as we expand outward into the solar system to use resources that lie scattered all over the asteroid belt, to settle our Moon and planets. A far more sophisticated and refined U.S. astronaut corps is in the making,

and these 21st-century professionals may yet spring from our newly homegrown commercial and private space enterprise.

Among policymakers, where logically sensible ideas often die a fiery death because of partisanship, space activity is a rare arena where all agree. Above the din and acrimony of political theater, beneath the cloak of it all, both aisles of Congress and even fringe groups among the leadership support a vibrant space program. The space station partnership has built a venerable coalition of international partners and could be extended into a global effort with the blessing of the State Department that could use it as an instrument to enhance the U.S. image, not just among partners but around the world.

Astronauts' training and mission expertise, combined with their unique aura and refined sensitivity about our biosphere and the rich and complex interweave of humanity in it, make them a new generation of 21st-century global ambassadors, the few who have experienced a global view of things, literally, with a stamp that says "made in America." They may hold the key to switch the fear-and-greed paradigm that seems to run rampant in the world today with hope, awe and wonder of nature and keep alive humanity's noblest aspirations, including our place in the universe, the *raison d'être* for human spaceflight.

*Madhu Thangavelu is conductor of the graduate Space Exploration Architectures Concept Synthesis Studio in the Department of Astronautical Engineering within the University of Southern California's Viterbi School of Engineering, and he is also a graduate thesis adviser in the School of Architecture at USC.*



November 24, 2014

# ON THE MOVE



■ **THE AEROSPACE CORP.** elected **CHARLES BLANCHARD** (above) to its board of trustees. He is a partner at Arnold & Porter LLC's Washington office, where he specializes in national security practices and government contracts.

Prior to joining the firm, Blanchard had been general counsel and chief ethics officer for the U.S. Air Force. There he oversaw more than 2,600 military and civilian Air Force lawyers around the world. He had also served as general counsel to the U.S. Department of the Army, chief counsel to the White House Office of National Drug Control Policy. As a partner in private practice he focused on complex commercial litigation, antitrust, state constitutional law and election law.

Blanchard also served as a two-term member of the Arizona State Senate and in as interim homeland security director for former Arizona Gov. Janet Napolitano.

The Aerospace Corp., a federally funded research and development center, also announced several leadership changes.

**KEVIN BELL** succeeded Glenn Davis as general manager for the Imagery Programs Division in the National Systems Group. Davis was promoted to vice president of strategic space operations, as was announced previously.

**TODD NYGREN** succeeded Bell, taking his previous position as general manager for the Systems Engineering Division in the Engineering and Technology Group.

**ANDREW DAWDY** succeeded Nygren, taking his previous position as general manager of developmental planning and architectures for the Space Systems Group.

"These leadership changes are in line with our succession planning, announced previously in September, and our continued focus on delivering mission success to our customers," Wanda Austin, the Aerospace

Corp. president and chief executive, said in a statement.

■ **QUALIS CORP.**, a small technical services company based in Huntsville, Alabama, has appointed **CARLOS KINGSTON** vice president of its Missiles and Space Group. In his new position, he will direct Qualis contracts involving space and missiles as well as develop a strategy for the company to serve U.S. military personnel.

Kingston had spent the past 30 years in senior positions with the U.S. Army and the Missile Defense Agency. Most recently, Kingston was program director of the MDA's Ground-based Midcourse Defense (GMD) program. There he was responsible for integrating GMD into the nation's ballistic missile defense capability, and reported to MDA Director Navy Vice Adm. James Syring.



■ Mineralogical entrepreneur **JULIAN MALNIC** (above) has joined the board of directors of asteroid mining startup **DEEP SPACE INDUSTRIES**. He is the founder of Nautilus Minerals Inc., an undersea mining company, and Direct Nickel, a company that has developing a novel way of extracting nickel.

Malnic had been acting as an adviser to Deep Space Industries since before its public unveiling in January 2013. Besides his entrepreneurial ventures, he is the founder and chairman of the Sydney Mining Club, managing director of Fluid Minerals Limited and director of public relations for the Constitution Education Fund of Australia.

"Not only is he a geologist with a lot of processing experience, but he is also founder of the world's first deep sea mining company," Deep Space Industries Chairman Rick Tumlinson said in a statement. "He brings us an invaluable level of experience in transformatory mineral resource ventures."

*Compiled by Clinton Parks,  
cparks@spacenews.com*

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November 24, 2014

# PROFILE

## Yvonne Pendleton

DIRECTOR, SOLAR SYSTEM EXPLORATION RESEARCH VIRTUAL INSTITUTE

# The Moon and Beyond



NASA PHOTO

When NASA established the Lunar Science Institute at the NASA Ames Research Center in 2008, the space agency was in the midst of the Constellation program with plans to return astronauts to the Moon by 2020. Since President Barack Obama announced plans in 2010 to refocus the U.S. human spaceflight program on travel to a near-Earth asteroid and ultimately to Mars, NASA officials have looked for ways to expand the mission of the institute to reflect the changing priorities of the space agency.

In late 2013, the Solar System Exploration Research Virtual Institute (SSERVI) officially took over the work of the Lunar Science Institute. SSERVI supports research designed to shed light on fundamental questions related to the Moon, near-Earth asteroids, Mars' moons Phobos and Deimos, and the space environments near each of those bodies.

Yvonne Pendleton, who became director of the Lunar Science Institute in 2010 and now leads SSERVI, is shepherding the organization through the transition. In November 2013, SSERVI selected nine teams to embark on five-year research projects. The teams are led by Bill Bottke of the Southwest Research Institute, Dan Britt of the University of Central Florida, Ben Bussey of the Johns Hopkins University's Applied Physics Laboratory, Bill Farrell of NASA's Goddard Space Flight Center, Tim Glotch of Stony Brook University, Jennifer Heldmann of NASA Ames, Mihaly Horanyi of the University of Colorado, Carle Pieters of Brown University and David Kring of the Lunar and Planetary Institute.

SSERVI also has international partners: the Canadian Lunar Research Network, the Korea Advanced Institute of Science and Technology, the Saudi Lunar and Near Earth Objects Science Center, the Israel Network for Lunar Science and Exploration, the German Network

for Lunar Science and Exploration, Frascati National Laboratory of Italy's National Nuclear Physics Institute, nine institutions that form a SSERVI node in the Netherlands, and 15 institutions that form the



United Kingdom node.

Pendleton, an astrophysicist, decided she wanted to work for NASA when she was a child in Key West, Florida, watching rockets launch from the Kennedy Space Center. She obtained a bachelor's and a master's degree in aerospace engineering before shifting her attention to astrophysics and earning a Ph.D. at the University of California, Santa Cruz.

In 2007 and 2008, Pendleton served as the senior adviser for research and analysis programs for NASA's Science Mission Directorate in Washington.

Pendleton spoke recently with *SpaceNews* correspondent Debra Werner.

### Why was SSERVI formed?

The institute was created because complex science and engineering challenges require expertise and resources across many disciplines. By eliminating geographical constraints, the virtual institute model enables us to select the best investigations, teams and resources to address NASA's current goals, regardless of where team members or infrastructure are located.

### What do you focus on?

We tried to come up with questions we would need to answer before people travel beyond low Earth orbit. The topics include things like trying to understand how small bodies would outgas material. If you were approaching one, you would need to understand that. From a science perspective, volatiles are incredibly interesting to people who want to understand the origin, evolution and composition of these bodies.

### How much funding does SSERVI have?

If you add up every single dollar, including the dollars for civil servant salaries, the total budget is \$15.2 million per year. The central office gets roughly \$2.8 million. The teams, on average, can expect to get about \$1.2 million per year for five years.

### Five years is a long time for a research project.

Yes. That is one of the reasons we have the flexibility and the stability that we have. Five years is a long enough time for someone to take a graduate student from the early days all the way through. We have seen students graduate from one team and become postdocs in another

team. Students provide this unique glue that binds the institute together in a way I had not anticipated.

### How often will SSERVI seek new research projects?

Every two-and-a-half years, we plan to have another call for proposals. That way we can add new teams before the old teams finish their five-year projects. That provides continuity and enables people to share the philosophy and culture of the institute.

### What has SSERVI accomplished?

We picked teams in November. I got the teams together in December and asked them to come up with ideas for collaboration. They formed a long list and they've been marching right down that list.

One was the idea of having a shared repository of samples that team members collect. If they go into the field to collect meteorites or rock samples that other teams want to analyze, they work from the same rock. They also share facilities, laboratory resources and students. Some teams are taking other teams' students with them on trips to analog work sites.

The teams are already publishing papers together. We use the publication rate to measure productivity. In six months this group has published 35 papers and there are more in the works.

### What's ahead for SSERVI?

At the American Geophysical Union meeting in San Francisco on Dec. 15, we will have an entire day dedicated to SSERVI research topics. We hope to draft a second Cooperative Agreement Notice to be released in late spring of next year.

We have recently been asked to take on management of NASA's Lunar Mapping and Modeling Project (LMMP), which includes data from multiple instruments on multiple lunar missions. All of this data is put into a system with very sophisticated modeling capabilities. It allows users to combine different layers of data. NASA's Jet Propulsion Laboratory is doing the work. Now that we've taken over management, we have asked them to expand beyond the Moon. As SSERVI's scope grows, so should LMMP's. We have included Vesta and Mars, and we hope to include the moons of Mars in the near future.

### What role do SSERVI's international partners play?

They play a huge role. On a no-exchange-of-funds basis, we collaborate. Some space agencies are making discoveries at a breakneck pace. Our job is to connect them, to help disseminate each country's expertise and results across the globe in a way that makes them useful to everyone.

### How do international partners join SSERVI?

They write proposals with an eye toward how they can fit into the kind of work our teams already are doing. They often offer to send students here or bring U.S. students there. Some of our teams do a lot of analog

work, trying to understand the moons of Mars or asteroids by going to remote places on Earth. Canada has some ideal places for this kind of work. The partnership with Germany enabled one of our teams to build a dust accelerator in record time. Mihaly Horanyi's German colleagues gave him the plans to build a duplicate of their accelerator. It is now open to the entire scientific community.

### How many people work on the SSERVI staff and what role do they play?

There are 14 people on the SSERVI central staff. We oversee the teams and make sure they get their funding. We track their budgets and learn about their progress in monthly meetings. We enable a lot of the virtual communication both for our teams and for the whole community. NASA is getting very interested in using virtual tools for a number of meetings.

### Why is SSERVI at NASA Ames?

Ames is home to all of NASA's virtual institutes: the NASA Astrobiology Institute, the NASA Aeronautics Research Institute and SSERVI. Ames is an innovative center. People here are very interested in cost-savings approaches to exploration. I think the institutes are thriving because we are in the heart of Silicon Valley. We pick up a lot of virtual tools hot off the press and introduce them to our community.

### What made you switch from aerospace engineering to astrophysics?

When I was 10 years old, I told anybody who would listen that I wanted to work for NASA and study the stars. I went into aerospace engineering at the Georgia Institute of Technology. The year I graduated I had an opportunity to work for Ames and get my master's degree at Stanford University. Once I got here, I realized Ames had a space science division. I wandered over there one day and fell in love with everything they were doing. This was the time of the Voyager and Pioneer missions. I was mesmerized. At the time, I was working in a wind tunnel. Fortunately, human resources let me switch, and the rest is history. NASA put me through to get my Ph.D. in astrophysics. I ended up having the career that was right for me.

### So now you work for NASA and study the stars?

That's right. In my personal research, I look for the cosmic origins of life in a grain of interstellar dust. Now I have the joy of directing an institute focused on our place in the solar system. I believe the Moon and other small bodies in our solar system hold the pieces of the puzzle we need.

### You also have your own asteroid, 7165 Pendleton.

I was blown away when that happened. It was a huge honor.

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